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AND

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BRITISH FOUNDRYMEN'S ASSOCIATION.

Notice to Members.

By the kind permission of the Governors the second annual convention of the members of the British Foundrymen's Association will be held in the new Lecture Hall of the Glasgow and West of Scotland Technical College, Andersonian Buildings, 204, George Street, Glasgow, on Monday, Tuesday, and Wednesday, 7th, 8th, and 9th of August, 1905.

At 10 a.m. Monday, 7th August, a business meeting will be held for the election of officers, etc., for the ensuing year, and is open to members only. This will be followed by a public meeting at which will be delivered an address by the President, Mr. Robert Buchanan. Papers will be read by the following gentlemen:—

Mr. Herbert Pilkington, M.I.M.E., Vice-President.

Professor Sexton, F.I.C., F.C.S., an address on "Technical Education and the Foundry."

Mr. A. Campion, Carnegie Research Scholar, "The Microscope and Pig-iron."

Mr. Percy Longmuir, Metallurgist and Carnegie Medallist, "Moulding Sands and Fire-Clays."

Mr. John G. Stewart, "The Commercial Side of the FoundryM Trade." Other papers will be read if time will permit.

A number of micro-sections of metals will be shown in the Laboratory, and descriptions given by the assistants in the College. This has been kindly arranged by Professor Sexton.

A large number of photo-micrographs, showing the effects of various elements on iron, will be shown. These have been kindly lent by Mr. A. H. Hiorns, Principal of the Metallurgical Department, Birmingham Municipal Technical School.

Visits will be made to the Carron Iron Works, and to the largest steel foundry in Scotland by the kind permission of the respective general managers (admission to members only).

Negotiations are also in progress for visits to other works if time will permit.

Detailed programme will shortly be issued to members.

New applications for membership should be sent in at once.

F. W. FINCH,
Secretary,
Kingston House, Lansdown Road,
Gloucester.

THE LOCHNER DRYING PROCESS.*

ONE of the most important considerations in foundry work at the present time, in view of the necessity for keeping down the cost of production, is the prevention of waste and the thorough utilisation of fuel and other items involving outlay.

A step in this direction is made by the Lochner drying apparatus, which obviates the necessity of using fuel to effect the drying of the moulds, and quickly brings both cores and moulds into proper condition by means of the heat stored up in the castings.

The arrangement of the drier is shown in Figs. 1 and 2. It consists of two chambers A and B, separated by a perforated plate D (the holes in the plate are marked C). Cold air is admitted into the chamber A through the pipe E, and, ascending into B, is distributed evenly through the latter by the perforated plate. The chamber B forms the drying chamber for the cores, and also contains the hot castings which serve as heaters. B is closed at the top by a hinged cover F, the flanged edges of which fit into channel irons filled with sand to prevent leakage of heat. The cover is provided with a number of holes G, which can be closed by means of plugs; and it is above the holes in this cover that the moulds are set to dry.

The operation is very simple, the finished cores being placed in the chamber B, and as far as possible on the one side. On the other side are placed the castings, which are still very hot (an hour or so after removal from the moulds), and have merely been cleaned of the adhering sand, whereupon the cover F is shut down. At first the holes in the cover and the valve H in the air pipe are kept closed, so that the chamber B and the cores may get hot without delay. This done, some of the plugs above the cores are taken out to allow the water vapour to pass out of the chamber. The air-inlet valve being still shut, the effluent gases are mainly superheated steam at a temperature of about 250 degrees C. The mould boxes are now placed on the cover F, several of the plugs G being first taken out to admit heated air from below to enter the moulds. When the latter are of large diameter it is advisable to lay a small bench J over the holes G to constrain the ascending hot air to rise alongside the walls of the mould. When all the moulds have been placed on the cover F, and not before, the air-inlet valve H is opened, whereupon a brisk circulation of air ensues. The bulk of the moisture from the cores has meanwhile been expelled, and the little still remaining does not retard the drying of the moulds.

It is evident from the foregoing that the drying process is quite different for the two articles. In the case of the cores the moisture is evaporated by a high temperature and with exclusion of air, whereas that in the moulds is absorbed by hot air and carried off.

The process offers numerous advantages, the direct pecuniary saving being the most apparent, namely, the entire abolition of fuel and the expense of attendance. In addition, there is a saving in the cost of conveying the cores to the drier, since they can be made on the spot; the moulding sand can be used over again on the spot without any further preparation, since it is brushed off the castings before it has got burnt. There is also a saving of room, both the cores and the castings disappearing under the floor level; and the working capacity of the men is increased, especially in summer, since they are not exposed to fatigue caused by the radiant heat of the hot castings.

Not less interesting and, perhaps, equally valuable, is the influence of this drying process on the castings themselves. One special application of the process is in the production of chill moulds, which must be cheap, and yet strong enough to stand repeated use; they must be quite smooth inside and level at the bottom, so that the resulting ingots may be quite smooth, and come out easily when stripped. The usual end of these moulds is to crack and become rough, defects which it is the task of the foundry engineer to retard as long as possible, and to prevent one occurring sooner than the other. If successful, the mould can be kept in use until soft right through and has to be thrown aside on account of decrepitude.

Now, the influence exercised by the Lochner process on the durability of chill moulds is as follows: The cracking or bursting of the moulds is mainly the result of an increase in the tension as soon as the mould is filled with steel, and also as

* O. Wedemeyer. "Stahl und Eisen."

a consequence of the greater deformation of the interior of the mould by alternations of heat and cooling than is produced on the outside. Since the hot chill moulds used for heating the drying chamber are freed from their envelope of sand whilst still white hot, and placed in a tightly closed chamber, they cool down quietly and uniformly—a process exceedingly favourable from the standpoint of stresses in the metal. The only other strains are those of tension caused by the inner part of the chill moulds retaining heat longer than the outside. These tension strains, however, are beneficial rather than the opposite, since they help to counteract the

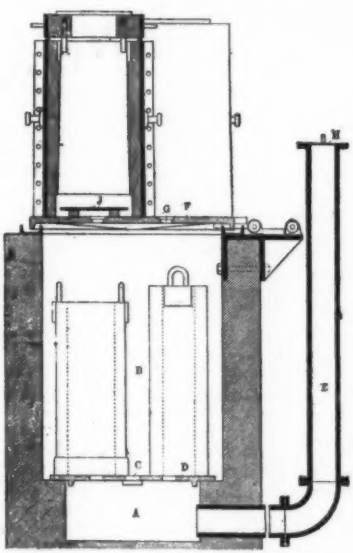

FIG. 1.

deformation already mentioned. The roughening of the inner surface of the chill mould being caused by the action of the molten steel on the skin of the mould, and will therefore proceed the more rapidly in proportion as this skin is rougher and more uneven. The problem, therefore, is to have the inner walls as smooth and unbroken as possible—a result admirably accomplished by means of the apparatus now in question. If the cores are dried in the usual manner a dry crust is first formed; but as they grow warmer the steam from the internal moisture forces its way through, and more or less injures the superficial crust; cracks are formed, and oftentimes the crust flakes off and has to be patched, or the core thrown away. Moulds made with these cracked cores exhibit corresponding ridges on the surface and are uneven, the core crust being forced in or aside by the molten metal, and giving a defective mould. All these undesirable features are abolished by the use of the Lochner process. The cores are sleeked while damp, and placed in the drier, where the heat from the castings warms them so suddenly that there is no time for a crust to form. They get hot right through very quickly, and the vapour coming from the centre prevents premature drying of the outer layers. The cores thus dry from the centre outwards, and if well made will be as smooth and free from cracks and other defects as they were before, no final sleeking or blacking being needed. The same applies to the moulds and their accessories; they do not need

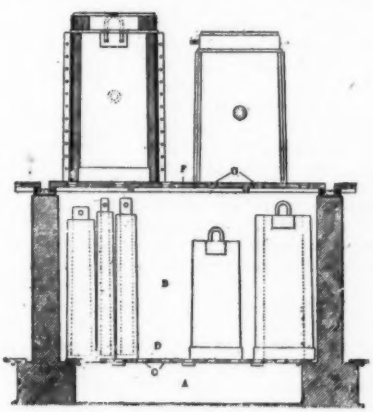

FIG. 2.

cleansing from ash, and core and mould can be put together at once for use.

The Lochner drier costs comparatively little to set up, and as there is no wear and tear, the upkeep is trifling. As an instance of the capacity of the drier it may be mentioned that chill moulds up to eight tons in weight can be moulded, dried, and cast within 24 hours. It can also be used in the production of tubbings, and considerably reduces the unfavourable stresses set up, owing to the special shape of these moulds during cooling. Rolls, too, and in fact any thick goods to be produced in quantity are favourably dealt with by this apparatus.

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MR. A. F. SMITH, of the Kennet Iron Works, Reading, has erected a new foundry at his works.

MOULDING A CYLINDER IN LOAM.*

By F. W. Finch (Hon. Sec., British Foundrymen's Association).

In taking the subject of moulding a cylinder in loam for my paper, I feel I am taking up a subject not of special interest to engineers generally, but, considering the important part moulding takes in the engineering trade, I hope my paper will meet with approval from members of this Society. How few who call themselves engineers understand moulding. Take, for instance, what we call "gentlemen apprentices." Very few of them go into the foundry; they take pattern-making, turning, fitting, and the drawing office, thereby losing that knowledge which is very essential in making a drawing, as very often there are parts in a casting that puzzle the pattern-maker and moulder to get them out of the sand, and very often the drawing has to be altered to allow for this.

"How sublime and grand is the structure of the steam engine—the mighty power of machinery. Yet, useful and ornamental castings, used in all shapes and forms, are made from pig-iron and old scrap-iron, and formed in sand. For all this, all thought is of the work of the pattern-maker, or the machinist. It is not till some scabs or sand holes in the castings are noticed that the moulder is mentioned. Then, what abuse the poor moulder does get."

All moulders are not thorough-paced; if they were, there would not be half the trouble there is in getting good castings. There is no trade that requires more long-headed, cautious, and mechanical operations than that of a moulder. Why is it that all the castings made in a foundry cannot be good and perfect like the day's work of a machinist, blacksmith, or boiler shop? Is it because the men and boys that learn moulding are such as are rejected or not allowed to learn other trades on account of being blockheads? The moulder's trade is learned by boys and men the same as any other trade, and foundry bosses are as good judges of character as any other class of foremen. Few foundries would hire a boy that wore kid gloves and a collar that holds his head up. Such boys are generally selected from sound and staunch material. Taking it for granted that as good and as smart boys learn moulding as learn other trades, is it to be taken for granted that they fail as a class when they become men? The more that is thought of the matter the more it looks as if it was the want of a knowledge of moulding more than the lack of mechanical ability that causes all this trouble of bad castings. The ramming of sand is what any one having the necessary strength can do; but the light or heavy ramming required on the different sections of a mould, demands something more than strength and stupidness. The motion of the rammer is visible; the result of the ramming is invisible.

Loam Moulding.

Loam moulding has now become a very important branch of the foundry and pattern-shop practice, for almost all cylindrical work of any size and weight is now struck up in loam. This results in a saving to the employer in many ways. In most instances there is at least 50 per cent. less pattern-making in preparing for a loam mould than there would be if a full pattern were made for the same job. Of course, some portion of the gain in pattern-making is lost by the extra time taken in moulding, but this is not of serious consequence. Then again, the loam-boards do not occupy nearly so much storage room as would the full patterns, and this in most large engineering establishments is an important item.

I propose in this paper to fully describe the process of moulding a steam engine cylinder in loam. This is looked upon as one of the most important pieces of work, both in the pattern shop and in the foundry. There are, of course, a variety of steam cylinders, but the one herewith illustrated will serve to describe the process of moulding. Figs. 1, 2, and 3 are different views of a steam cylinder of the ordinary cut-off type. Fig. 1 is the longitudinal section showing the interior of the valve box, and a section through the steam and exhaust ports. Fig. 2 is a section on A B on the longitudinal section, and shows the width of the valve box and exhaust port. Fig. 3 is a section on C D giving a transverse section of the steam port as it runs from the valve chamber to the inside of the cylinder. These are the only three views necessary from which to prepare the pattern. Fig. 4 is an illustration of the loam moulder's footstep, spindle, and bracket. A is the footstep into which the spindle B fits, and upon which it revolves as the mould is being struck up; C is the bracket to which the loam-boards are bolted.

Looking now at Fig. 7, the dotted lines at N, N, show the seating on the base of the mould. This is the first portion of

* Paper read before the Bristol and District Employers' Association.

the mould to be struck, and forms the foundation for the remainder of the work. To form this seating the moulder will require a loam-board, as shown in Fig. 5. The line A, A, is the centre line of the cylinder; from this line to B is the radius of the cylinder flanges, allowing $\frac{1}{4}$ in. for turning. From C to D is the thickness of the flanges, allowing $\frac{1}{4}$ in. for facing across. The moulder will also require for this seating a cast iron plate to strike it upon, shown in Fig. 6. This tackle he usually prepares for himself, making it large enough in diameter to allow the lugs at A B C D to project outside the brickwork. Two of these plates will be required, one for the bottom or seating, the other one for the top or cover. They should be made $1\frac{1}{2}$ in. thick. Having struck and finished the seating, the surface of it should be skin-dried preparatory to striking the outside mould of the cylinder. Fig. 7 is an illustration of the finished seating after the seating-board and spindle have been taken away and replaced by a long spindle with the loam-board for striking the outside mould of the cylinder. It will here be seen that the spindle A, Fig. 7, being long, it is necessary to stay it at the top to prevent it from moving while the mould is being struck up. If this is not done unpleasant consequences may follow. A joint will be made with parting sand and dabbers where the bottom of the outside mould joins on to the seating, and a cast iron plate will be used similar to the one shown in Fig. 6, but only 1 in. thick. Fig. 8 is the loam-board required for striking the outside of the cylinder; the line A, A, being the centre line of the cylinder, the dotted line B the radius of the flanges, allowing

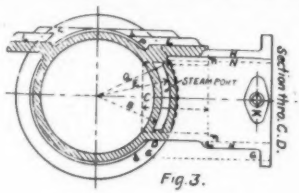


Fig. 3.

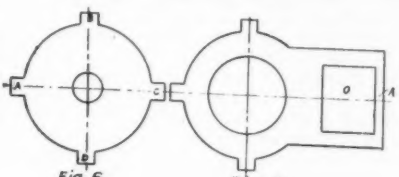


Fig. 6.

Fig. 9.

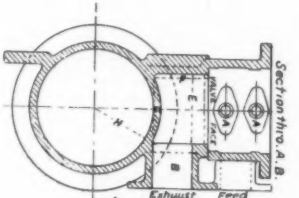


Fig. 2.

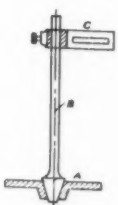


Fig. 4.

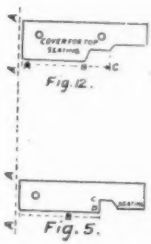


Fig. 12.

Fig. 5.

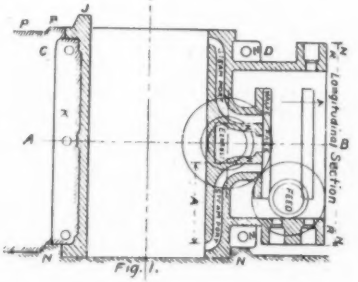


Fig. 1.

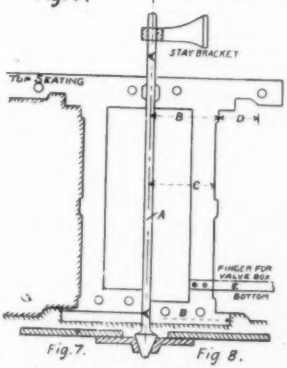


Fig. 7. Fig 8.

¼ in. for turning; the dotted line C the radius of the body of the cylinder; and the dotted line D shows how the seating is struck, on to which it is intended the cover shall fit. In striking up the body the moulder will build up until he gets within 2 in. or 3 in. of the valve box, when he will require another cast iron plate of the shape shown at Fig. 9, and about ⅜ in. thick; this he will prepare himself. The inside diameter of the plate will be about 1½ in. larger than the outside diameter of the cylinder, and the outside diameter of the plate must be large enough to carry the brickwork. The projection shown at A is to carry the brickwork for the steam chest, the slot cast in at O being provided for the steam chest flange and valve spindle stuffing boxes to pass through; they should be large enough to admit of a good coating of loam. Having fixed this plate the moulder will require a finger fixed to the loam-board, as shown at E, Fig. 8. This is to strike a level bed for the steam chest pattern to rest upon, and is taken off when this is completed. In making the steam chest pattern it should first be boxed up to the length with 1½ in. timber as shown by the dotted line N to N (Fig. 1), with a width as shown by dotted line F to F (Fig. 3), while the depth will be regulated by dotted line G to G (Fig. 3). On the side intended to fit against the loam-board it will be cut out to a sweep, corresponding with that shown at dotted line B (Fig. 3); the pieces H H will be put on separately, and, of course, carried the full length of the box and to a depth sufficient to ensure a thickness of metal at the corners J below the valve face. The valve box flange will be framed together out of timber about 6 in. wide, and thick enough to allow $\frac{3}{16}$ in. planing off the face when cast. The corners must be half-lapped. If the flange is cut out of a plain piece of timber without framing, it will warp and twist about when it is brought into contact with the damp mould. Put a print on the face of the valve box about 2 in. thick, and the length and width as the opening in the valve box requires. Pin the stuffing boxes A A (Fig. 2) and K (Fig. 3) loose to the pattern with ordinary wire; fasten the exhaust and feed branch pipes on with wood dowels; screw the cylinder foot Z (Figs. 1, 2, and 3) to the side of valve box; attach this to the cylinder foot K by means of a strong batten, as shown at L (Fig. 3). The valve box and cylinder feet will then be set altogether in the mould, and the moulder may take off the battens and loosen the feet as he approaches them. When the moulder is ready to fix the valve box, the pattern-maker should go into the foundry and assist him in setting it. This is done by setting the steam chest parallel with the loam spindle, and causing the loam-board to work smoothly past it at P P (Fig. 3). When this is done satisfactorily the moulder will build up right away to the points P P (Fig. 1), using another plate on the top of the valve-box similar to the one at the bottom (see Fig. 9). In building in the valve-box he will leave it open at the flange R R (Fig. 1), so that the pattern may be withdrawn from the mould in the direction of the arrow. A seating will be struck at the joint P P for the cover to fit on. The outside mould is now finished, and may be lifted away to allow the main core of the cylinder to be struck. This is done on the same seating and with the same spindle. Fig. 10 shows the seating with the outside mould lifted away and the loam-board for the centre core secured to the spindle ready for striking the main core. In the case of the outside mould, Fig. 7, it will be observed that the loam-board revolves inside the mould, whereas, in Fig. 10, the loam-board sweeps round the outside of the mould. Fig. 11 is the loam-board required to strike up the centre core, the line A A being the centre of the cylinder, while from B to C is the radius of the cylinder (inside diameter) allowing ⅜ in. for boring out; from D to E is the total height from the seating N (Fig. 1), to the top side of head J. This head should be about 6 in. to 8 in. long, according to the size of the cylinder, being cast on to gather any dirt that may accidentally fall into the mould and from the iron. The loam-boards shown at Figs. 8 and 11 can either be joined at the corners with battens screwed on to hold them, or half-lapped, which latter many pattern-makers consider the strongest and best finished job. When the core is finished it will be run into the stove to dry. Fig. 12 is an illustration of the loam-board required to strike the loam to fit on the mould at the joint P P, Fig. 1, the line A A being the centre of the cylinder. From the line A to B is the radius of the head cast on the top of the mould, and the line from B to C is the seating, and should be about 3 in. wide.

We will now suppose that the loam-boards and valve-box patterns are finished. We have now the core-boxes to construct. Fig. 13 is a plan and longitudinal section of the steam chest core-box. This box is framed together in the ordinary manner, the end being let about ¼ in. into the sides, as shown in plan. The length and width of the box should be a little smaller

than the print on the valve-box pattern to save the trouble of rubbing the core when putting in the mould. The depth is shown at the dotted line N, Fig. 3, allowing 2 in. for the print on the valve-box pattern, and 1 in. for thickness of timber at the bottom of the core-box. A piece of timber will require fitting into the box at the block A, Fig. 13, allowing $\frac{3}{16}$ in. for facing at the face B B; the projections C C will be wired on loose up to the dotted line for the convenience of the core-maker; a facing strip will want sprigging on loose at E and F. G and J are prints to receive the ends of the steam port cores. H is the print to receive a portion of the exhaust core. K is a print about $\frac{1}{2}$ in. thick to receive the end of core for feed; the branch pieces N N in core-box must be struck to a radius corresponding to the dotted line at Q (Fig. 3). The exhaust core will be made in two pieces for convenience of putting in the mould, that portion which passes through the branch at B (Fig. 2) will be a plain piece of core; the portion which cuts through into the valve chamber will be of a length and depth, as shown by the dotted line E and dotted line F (Fig. 2), allowing for facing on the valve face. The print in the valve chest box and thickness of timber is shown by the dotted line G. The bottom of the box will be struck with a radius as shown by the dotted line H. In making the box frame—a plain box of the required depth, length, and breadth—prepare two pieces and screw on to the sides, as shown at the exhaust section (Fig. 1), by dotted lines. The pieces lettered N N are screwed in. The steam port core-box may be prepared in different ways. I will endeavour to submit the most economical method, both as regards time and timber. Fig. 14 is a section of the core-box when put together. Take first a piece of timber long enough to make the bottom A and end B; plane true on one side and one edge, gauge and plane off to the exact width of the steam port; cut B off to the required length as shown by dotted line A at Fig. 3, allowing 1 in. for the print in valve chamber core box, $\frac{3}{16}$ in. for boring in the cylinder, and $\frac{1}{4}$ in. for letting into the bottom A, at Fig. 14, to prevent it moving when the core-maker raps the box. Next cut a piece to work the hollow C, keeping the longitudinal direction of the grain in a vertical position; this will prevent the feather edge from curling away from B. Now cut a piece for D, plane it to the same width as A and B, cut to a length so that D and C will form a total length, as shown by the dotted line at A, Fig. 1. D will require striking with trammels and planing to a sweep, as shown by the dotted line from centre at B, Fig. 3. The dotted line C,

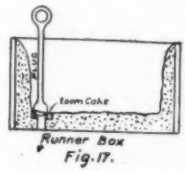


Fig. 17.

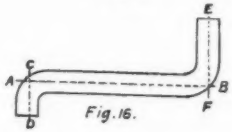


Fig. 16.

Fig. 15.

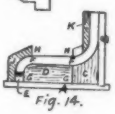


Fig. 14.

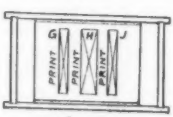
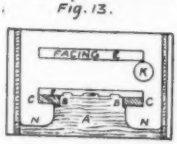


Fig. 13.



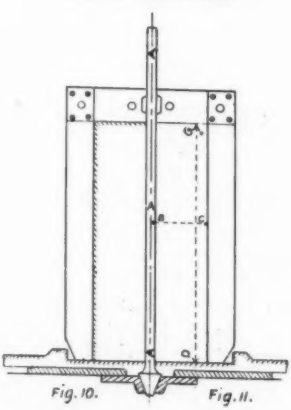


Fig. 10. Fig. 11.

Fig. 3, shows the thickness of D on the line F F (Fig. 14). We must now put in

a piece at E; this is where the steam port core cuts through into the body of the cylinder and must be struck to the internal diameter, allowing $\frac{3}{16}$ in. for boring out. The box will now require two sides as shown; the height from G to H will be as shown by dotted line at D (Fig. 3); screw pieces on at J and K, which must be left so that the core-maker can take them off after ramming up the core. Make a strickle as shown at Fig. 15, with which to strike the top of the core from the edge of the sides H, which will be struck as shown, to the sweep by the dotted line E (Fig. 3). In making the cores for the cylinder the greatest care must be taken by the core-maker in venting the cores so that the air can get away sufficiently while casting, for if the air cannot get away it is almost certain that something will go wrong. The most difficult core to make is the steam port, because of the irregular shape of the core. This cylinder being a large one the air is got away by putting a bent wire through the core, as shown by dotted lines A to B, C to D, and E to F (Fig. 16). After the cores are dry, and before putting them into the mould, the vent holes A B C D and E must be stopped up, the air escaping through holes marked F through the print holes left in steam chest core. In small cylinders the air is got away in the following manner :—After the core is dry, it is scraped away in two or three places all along the core, and then a piece of thick twine is laid round where scraped out. It is then covered over with loam. The twine is then drawn out, thus leaving sufficient space for the air to get away. In up-to-date foundries vent wax is now used. The grid for carrying this core is made by bending irons to the shape of the core, and then some pieces welded crossways, forming it into what is called a cage grid. The air from the exhaust core is brought through the print hole in the steam chest core. In making this core some ashes are rammed up in the core and then well vented into the ashes. The air from steam chest core is got away by venting it well from the print side of core.

When the loam mould is sufficiently dried, it should be taken from the stove and put together. The outside mould should be lowered carefully over the core on to the seating N N (Fig. 1). The steam chest core will be provided with holes in order to attach the steam port and exhaust cores to the grid by means of screws. These three cores may go into the mould altogether or separately, as is most convenient, but in either case they must all be firmly attached to the loam plate which covers the valve-box flange at R R (Fig. 1). The cover may now be dropped on at P P, and the whole job firmly cramped together with iron cramps and wedges, the cramps being dropped over the projections on the top and bottom seating plates. The mould will now be lowered into the pit and rammed tightly in with green sand, and is then ready for casting, with the exception of making up the runner and risers. This is not considered by some people very essential, but in the opinion of others, besides myself, the running of castings is a very important point. The best method of running the cylinder described in this paper is by what is called plug-runner. The runner-box should be a large one, capable of holding a large quantity of metal. When ramming up pieces of loam, cake with holes in should be put in as near the one side of the box as possible, as shown by Fig. 17; before starting to cast, plugs are placed in the holes. When the runner-box is full of metal, the plugs are lifted, and the metal runs into the mould. By this method the scum and dirt from the iron floats on the top. The runner should be kept well filled till it overflows the risers, and if we have metal enough it will be better for flowing it through.

In conclusion, it does not follow that now we have cast the cylinder that we shall have a good casting. The loss of a casting does not imply that the moulder is ignorant, or is not a mechanic, since castings are often lost from some little insignificant cause.

Sometimes the excuses for bad castings are laughable. The story is told of a moulder who made four pieces—every one bad—and when the foreman asked him what was the matter, he said that one dropped, one flopped, one run out, and that one was a "waster." The boss told him to make one more, as he would like to know what would be the matter with the fifth one.

When a moulder loses a casting, it worries him. There is no trade in which a man's peace of mind is kept so unsettled as in the moulder's. He is always in a state of expectancy. Look at a moulder when he is taking his casting out of the bricks or sand with the hammer in his hand, he will look for something that he does not want to find. Should anything be seen that would make the casting bad, how soon the honest man's look of fear changes to despondency, or he shows his character by throwing the hammer down and stalking around the shop with a look of indifference, as much as to say that he was not responsible.

THE USE OF PLASTER OF PARIS IN THE FOUNDRY.*

By Edward B. Gilmour.

The title of this paper may seem a little strange, but as plaster of Paris is used to a great extent in most of the arts, it will not be so surprising to find it occupying a little corner in the foundry.

Plaster of Paris is gypsum burnt in a kiln at a temperature of 250 degrees and subsequently powdered and ground to a fine uniform flour. When so prepared it possesses the valuable property when mixed with water of setting into a solid mass. It receives its name from the fact that it is mined in great quantities in the environs of Paris, and is used to a large extent in art work. It takes a place in the foundry in the form of patterns; some founders use it to a large extent in making match boards. These match boards are not very satisfactory if they are kept in constant use, as they are brittle, and consequently very easily broken. While upon this topic I would say that good match boards are made from a mixture of litharge 3 parts, parting sand 90 parts, and linseed oil 7 parts.

The Use of Plaster of Paris in the Foundry.

In a large agricultural establishment with which I was formerly connected we used as much as 20 barrels of plaster of Paris per month, so it can be readily seen to what extent the material was used in this one place. It was the means of saving thousands of dollars in producing their work. We used it principally in the making of patterns for drop hammer dies, in order to straighten the malleable castings which had become warped in the process of annealing.

Our method of procedure was to take the original metal patterns before being gated up, place them in the sand as you would if you intended to cast them, viz., up to the joint, making the joint in the regular fashion, and as straight as possible. It is good practice to prove the drawing of the patterns so as to get the joint in the best place in order to get out the malleables after having been straightened. Now get a common wooden box, place over the mould, see that it has plenty of taper so as to facilitate the drawing of the plaster cast from the sand. Coat the mould with oil, mix the plaster with warm water (as you will get better results in setting) to a consistency of thick cream. Pour it into the box or flask upon one-half of the mould, and when solidified roll it over and take away the sand which made the original mould, leaving the patterns in place. Dress up the joint, again coating over the mould with oil, and repeat the operation upon the plaster mould, which will give you a perfect impression of the casting which you have to straighten. It is essential to cast a nut or something similar into the plaster in order to draw the plaster pattern out of the sand after it has become hard enough. It is necessary to trim up the mould, separate it and withdraw the patterns, repair all of the defects, and give the casts a coating of shellac varnish. They are then ready for use.

Some one may wonder why we use the original patterns in order to make the plaster patterns. The reason is simply this, that when you cast the dies from the original patterns you have the shrinkage of the casting in the die, you have also the shrinkage upon the malleable casting. It will be said that malleable castings shrink more than grey iron, which they certainly do. In making the patterns for malleable castings we allowed the same shrinkage as in grey iron, viz., one-eighth inch to the foot, but with the process of annealing the castings expand enough to bring "malleable" to a uniform size with grey iron castings, consequently the cast-

* Paper read before the American Foundrymen's Association.

ings are of the same size as the impression in the dies.

The accompanying cuts are two sets of drop dies for the pipe connections for a grain weighing machine, the smaller ones being used for the top dies. The method for making these plaster casts is a little more intricate, the moulds being made as you would make a regular loam mould, with sweeps having a frame made of the flat section, with pin holes on the centres, so that the sweeps will work on the circle as you would make a regular elbow or Y pipe.

In order to get as true and perfect castings as possible, we are very careful not to rap the patterns sideways, only a slight tap downwards being given. When the pattern is drawn no tools are used upon the face of the mould; simply take a camel-hair brush with wet blacking and carefully paint this on as regularly as possible; afterwards skin-dry the mould and you will have a perfect casting. We usually make these moulds in iron flasks so that we can leave them over night in the sand as it tends to toughen the metal, which, in fact, is a high-grade iron. These castings are subjected to very heavy strains on account of the continued pounding of the drop hammer.

—o—

QUERIES.

"Bronze" writes:—Can you recommend us a design for a furnace for separating the metal out of bronze dross and pot skimmings. Also a design or dimensions for a brick-built reverbertory furnace to melt three tons bronze.

* * *

Pressure.—I should like to know what difference of pressure there is on the walls of a mould whose metal is, say, 1 in. thick as against 2 in.—"Novice."

* * *

Answer to "Furnace" (May Issue):—I would advise him to adopt a fan for his cupola. By doing so he will find it more economical every way. The "Sirocco," by Davidson, of Belfast, is an excellent fan, and is much in vogue in these days for all purposes of wind pressure. But he might have a thing more primitive with very good results also. I saw a fan the other day at work with four very primitive blades, which were as flat as a flounder, and had done excellent work for more than twenty years. Pressure on water gauge 10 in.—"Ferro."

METAL MIXERS FOR FOUNDRY PURPOSES.*

By J. B. Nau.

It can be readily understood that the use of liquid metal directly from the blast furnace is fraught with many difficulties; and its indiscriminate use is liable to produce pipes of uneven and uncertain quality.

That this is so is well illustrated by the fact that some pipe specifications, in order to eliminate the factor of uncertainty and of uneven quality, prohibits the use of direct metal in the manufacture of pipes, and specifically states that the iron should be remelted in a cupola or an air furnace. Of course, this remelting leaves no excuse to the manufacturer in regard to the quality of his iron, but still it has disadvantages that cannot be overlooked, one of which is the greatly increased cost of the iron when thus remelted. Another disadvantage lies in the danger of deteriorating the quality of the iron to some extent by increasing its sulphur content from the contact with fuel or flame. The best and cheapest way would naturally be to mix the different brands of irons running from the various blast furnaces, and, if necessary, to correct the quality of the so mixed irons with irons remelted in the cupola. Such a proceeding prohibited by specifications is only possible where the foundry is built near the blast furnace. Foundries not so located are naturally excluded.

Still, in order to get all the benefit that the use of direct metal would undeniably afford, and yet avoid all the danger of the uneven quality, that alone guided the framers of the specifications in prohibiting the use of direct metal, the use of a heated mixer of sufficient capacity is here recommended.

Such mixers are being introduced in connection with steel works, and they give the very best satisfaction. Such a mixer is more in the nature of a gas-heated air furnace with the exception that the iron, instead of being melted in it, is brought liquid from the blast furnace and poured into the mixer, where it can be kept hot and liquid for any desired length of time.

Since steel works find that heated mixers give such good satisfaction, why should the foundrymen not follow in the same steps wherever it is possible to do so? The small non-heated mixer that the writer has seen in some German pipe

* Abstract of paper read before the American Foundrymen's Association.

foundries, gave good satisfaction, and the iron could still be used after two hours' waiting.

Heated mixers would give better satisfaction. Undoubtedly, under the action of the flame, which must be of a slightly oxidising nature, some undesirable refining of the iron would take place, and a small part of the silicon and manganese would be burnt out. But as the iron is poured liquid in the mixer, the oxidation of silicon and manganese would be much less than in the air furnace or the cupola, where from $\frac{1}{4}$ to $\frac{1}{3}$ of the silicon is burnt out, mostly during the melting period. In this respect the heated mixer, where no melting is done, should be far more advantageous. But it has other advantages. It is a well-known fact that the mixer, as such, is an excellent apparatus for eliminating in a short time a large percentage of the sulphur contained in the iron. In fact this elimination reaches easily 50 and 70 per cent. The quality of the iron will therefore be considerably improved in the mixer. In the cupola the contrary always happens.

Since the metal can be kept hot to any degree in the mixer, this affords us means to correct at once the quality of the metal by throwing and melting in it whatever cold pig may be necessary to obtain the right analysis.

Thus the use of the heated mixer for foundry purposes in connection with the blast furnace would seem to present very marked advantages:—

1. It would allow the use of direct metal from the blast furnace, thereby saving the remelting cost which is always high.
2. It would afford an easy and cheap means to eliminate a large percentage of sulphur, thereby, contrary to cupola practice, improving the quality of the iron.
3. It could be used directly to correct the quality of the metal by melting in it a certain amount of cold pig-iron, with probably less cost than when the melting is done in the cupola and with certainly less absorption of sulphur during the melting, because the solid pig will melt in the liquid bath and be removed from contact with the flame.

Naturally such a mixer could be used for other than pipe foundry purposes, when proximity to the blast furnace allows its adoption. It would even allow an independent large foundry to use liquid iron from a near-by blast furnace belonging to another company. Both companies would benefit by the practice.

Coming back now again to European pipe foundry practice, which led to the above consideration of mixers, it is in many other respects that improved means are applied, all tending towards a general cheapening everywhere. What one notices first in the most modern European pipe foundries is the complete absence of pits. The moulding and pouring is done on an upper floor to which one-half of each pipe flask is fastened; the other half is left free to be slid back. The flasks are never taken from their place; the finished pipe alone is lifted up by the crane, which having less weight to lift, can be lighter than would otherwise be the case. The lower end of the flask hangs freely down to within a certain distance of a lower floor and is accessible from every side. The drying of the flasks is obtained by means of producer gas or even blast furnace gas. The producer gas is made in gas producers situated outside the works and let through underground gas flues underneath the rows of flasks. Here special burners, varying in the different foundries, are used to dry each flask thoroughly and rapidly. In most places gas is also used to heat the core ovens.

In one foundry in Eastern France, where coke is very expensive, special arrangements are made to burn coke screenings from blast furnace coke in the core ovens.

The use of this fine coke, otherwise lost, was the cause of a very great saving in the drying of the cores. After the pipe is cast the sand falls from the flask and is taken up by conveyors, and after being cleaned and screened, is taken by conveyers to the top floor where it will be used again in the ramming of the flasks. In some foundries the flasks are put up exclusively in straight parallel rows; in others, especially for pipes of less than 25 in. diameter, revolving pits or drums are used.

In the case of revolver systems the drying of the flask is also obtained with gas. Some very ingenious drying appliances are used in these revolving systems.

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Messrs. J. W. Jackman & Company, Limited, of 39, Victoria Street, S.W., agent for the Pridmore moulding machine, inform us that Mr. H. E. Pridmore, the maker of these moulding machines, advises them that the International Harvester Company, of Chicago, have recently started to manufacture gas engines, and have placed an order for forty Pridmore moulding machines, which are to be fitted with patterns for moulding all the castings used in the construction of these engines.

BRITAIN'S EARLIEST IRON FURNACES AND MOULDING FLOORS.

By Thomas May, F.S.A. (Scot.).

The remains of smelting, refining, moulding, and other furnaces in sufficient completeness to enable the Roman methods of iron manufacture to be inferred have been investigated during recent excavations under my direction within the Roman fortifications at Wilderspool, and alongside of the great Via leading thereto, in the once adjoining township of Stockton Heath (before the Corporation, in whose premises the portable finds have found an appropriate home. The landowners, Messrs. Greenall, Whitley & Company, have also encouraged the work by their assistance and permission.

That these are the earliest of such remains discovered in this country is evidenced by the remark made by one of our ablest and most instructive writers on "Early Metallurgy, etc.," Professor Wm. Gowland, F.S.A., F.C.S., in 1900 (before the publication of my reports), that it was very surprising that "no *débris* of any furnace, sufficiently perfect

Fig. 1.—Base of Smelting Furnace (West View), Wilderspool, near Warrington.

cutting of the Manchester Ship Canal), near Warrington, and the following extracts, giving the metallurgical results of my explorations, are taken from my general reports* in the belief that they will interest your readers.

The excavations were initiated by a grant from the Historic Society of Lancashire and Cheshire in 1898, and were continued to the end of 1904 by private subscriptions and annual grants from the Museum Committee of the Warrington to enable us to deduce from it its original form, has yet been unearthed."* They are likewise the most interesting discoveries yet made upon the site, owing to their variety and completeness and their relation to one of our staple industries.

Sow-kiln floors, calcining ovens, smelting and crucible or refining furnaces, and moulders' floors have been uncovered in two separate spots, specimens of clay-band and hematite ores, unspent charcoal and cannel and ordinary mineral coal, slag and cinder, and iron in separate stages of manufacture (cast and pure) have been

* "Warrington's Roman Remains," by Thos. May, F.E I., F.S.A. Scot. Crown quarto, 5s. net, large paper copies 10s. net, from the publishers, Mackie & Co., Warrington.

* "Archæologia," Vol. LVI., part ii, p. 314.

collected from the vicinity of the furnaces and deposited in the Museum; and no fewer than twenty samples of ore, slag, cinder, and calcined clay from the walls of furnaces (the nature of which will be fully specified) have been analysed by Mr. Andrew Harley, of the Coalbrookdale Company, Limited (through the intervention of Mr. F. W. Monks, of Messrs. Monks, Hall & Company, Warrington), and by Mr. Fredk. G. Ruddock, F.I.C., analytical chemist, an expert of long experience in the analysis of iron and its ores.

The antiquity of the slags has been demonstrated by their composition. Association with a series of about 100 coins dating from the consular period (C. Octavius Augustus, before he became Emperor in 29 B.C.) down to Constantine the Great, A.D. 306-337, and with more than 500 fragments of the famous and familiar bright-red figured *terra sigillata* (Samian) pottery from the earliest period of manufacture previous to the destruction of Pompeii, A.D. 79, and plain vessels of the same description in still larger quantities, as well as grey and blue-black angular-bodied pots and locally-made pottery of the latest period of the Roman occupation, A.D. 410, leaves no uncertainty as to the Roman origin of the furnaces.

Iron Furnace No. I.

The earliest discovered and most complete of the iron-smelting furnaces (see Figs. 1, 2, and 3) consisted of a roughly T-shaped furnace cavity enclosed in a platform of stiff boulder-clay. The latter was from 6 in. to 2 ft. 6 in. thick, in the shape of two oblongs conjoined, measuring 13 ft. 4 in. by 5 ft., and 9 ft. 6 in. by 6 ft. respectively, both lying lengthwise from north to south or in line with the Via. In the midst of the larger or west limb of the platform and forming the cross-head of the T was a circular pit 2 ft. 4 in. in diameter and 3 to 4 in. in depth, having a fantail-shaped flue or stoke-hole opening from it northwards, 4 ft. 4 in. in length, its width increasing from 1 ft. to 2 ft. 1 in., and its depth decreasing from 4 in. to 1 in. outwards. Striking off at right angles to the flue at 1 ft. 3 in. from the circular pit there was a sloping trough closed at the outer end with clay, 6 ft. 6 in. in length, its width increasing from 1 ft. to 1 ft. 11 in., and its depth from 6 in. to 1 ft. 6 in. below the level of the flue, thus forming a gutter and basin for directing and collecting the molten stream from the

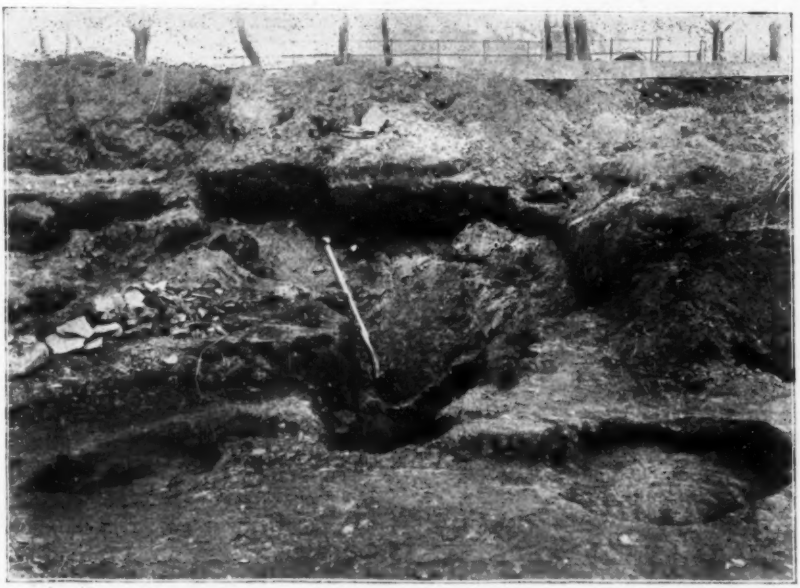

FIG. 2.—BASE OF IRON-SMELTING HEARTH (EAST VIEW), AT WILDERSPOOL.

furnace. A covered duct or return pipe from the outer end of the flue to the top of the sloping trough, and passing through the clay floor, served to convey any molten metal into the trough which had run past its open mouth.

The interior of these cavities was calcined to a dirty grey or light buff terra-cotta for a depth of 2 in., and the clay for more than a foot beyond was reddened by long-continued heat.

The solidity of the base of the furnace indicates that it was a permanent structure, and though there was no trace of a chimney it may be inferred that the circular hearth or pit was surmounted by a shaft of greater or less elevation, probably 3 ft. or 4 ft., for creating a draught. The coal in little cubes, as well as two nodules of clay ironstone and two small fragments of red hematite. The analysis of the latter by Mr. Harley gave the following results:—

	No. 1.	No. 2.
Ferric oxide... ...	90.560	96.12
Iron pyrites... ...	—	1.05
Alumina	—	slight trace
Lime	slight trace	,,
Magnesia	,,	,,
Phosphoric acid ...	,,	,,
Sulphuric acid ...	,,	—
Manganic oxide ...	—	—
Siliceous matters...	9.384	1.75

Both samples were red when ground, No. 1 containing more impurity and No. 2 being very hard and slightly crystalline on the edges. Several lumps of the slag were examined by him, but found to be

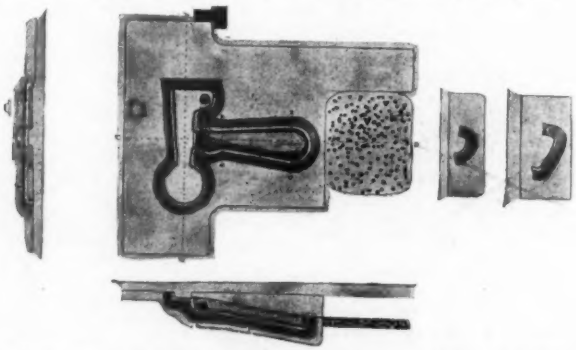

FIG. 3.—IRON-SMELTING FURNACES FOUND AT WILDERSPOOL.

flue and sloping trough were also partly or entirely overarched, the latter being found completely choked by a mass of clay reddened by heat and fragments of calcined upper crust from its overarched covering.

From the shape of the cavities it may be concluded that the iron ore was smelted by a continuous process, whereby the products of the circular hearth were at proper intervals run down into the basin at the bottom of the V-shaped gutter, and there separated. The lighter slag was probably removed by levigation or skimming over the lip of the basin, and the iron then ladled or tapped into clay moulds.

These conclusions as to the mode of working drawn from the shape of the furnace were confirmed by the position just outside the rim of the basin, at from 2 ft. to 2 ft. 6 in. below the grass, of a deposit blackened by spent charcoal fully 9 ft. in diameter and 6 in. deep of slag mixed with fragments of cannel and ordinary mineral very much alike, and the particulars of only one need be stated.

Silica	59.65
Alumina	13.41
Manganic oxide	.20
Ferrous oxide	18.14
Ferric oxide	3.84
Phosphoric acid	.18
Iron pyrites	1.46
Carbonaceous matter and moisture....	3.18
	100.36

In the opinion of Mr. Ruddock, "such a composition of slag could only be produced direct from the ore, at a high temperature, in a smelting furnace." That it is an ancient slag is evidenced by the entire absence of lime, of which from 20 to 30 per cent. is usually found in modern slag, the use of lime as a flux for removing silica being unknown to the ancients. A large proportion of the iron itself was, in consequence, necessarily consumed for fluxing the silica, causing great waste of material, as will be seen

from some of the analyses of slags to be given subsequently.

In order to leave no room for doubt as to the purpose for which the furnace was employed, the composition of the calcined skin from its interior was ascertained by Mr. Harley, with the following results:—Silica 53.00, alumina 22.17, lime 2.07, magnesia 3.38, oxide of iron 8.40, water of composition 5.44, moisture at 100 degrees C. 3.31. The percentage of ferric oxide in the natural clay of which the furnace was constructed is only 2.43, showing that a good deal of iron was absorbed from the operations.

That the Romans made and used cast iron, though formerly denied, is now certain from the discovery in 1901 of a Roman cast-iron statuette in a slag heap at Beauport Park, near Hastings, with other remains, which were exhibited in Lewes Castle on December 19, 1902;* and from the composition of a squarish block of cast iron found beside the iron purifying or crucible furnace I., already referred to and to be described later.

and measuring 8 ft. 9 in. from east to west by 4 ft. The furnace cavity was in the form of a deep footprint or two intersecting ovals, each about 2 ft. 6 in. in width, their conjoined length being 6 ft. 4 in. The interior surface was calcined and blanched to a depth of 3 in., and the soft clay underneath reddened to a further depth of a foot by the intense heat. By constructing the base of the furnace with a double batter, from both sides inwards towards the axis and along the latter towards the east end, it was formed into a sloping trough or gutter, leading down to a tubular duct, 1 ft. 10 in. in length and 4½ in. in diameter, through the wall of the clay platform at right angles, by which the molten metal was drawn off, as evidenced by its calcined interior lining. The purpose for which the hearth was employed is proved by the discovery of a much-oxidised strip of iron deeply embedded in a crack along the middle line of the trough near the exit, where it had doubtless lain since the last charge was smelted; and by the discovery of a mass of red hematite ore, of several pounds weight, in the clay platform of an earlier furnace, existing partly underneath the former and partly along its edge, whence the mass had apparently fallen. The results of analysis of the iron strip by Mr. Ruddock are the following:—

PLAN.

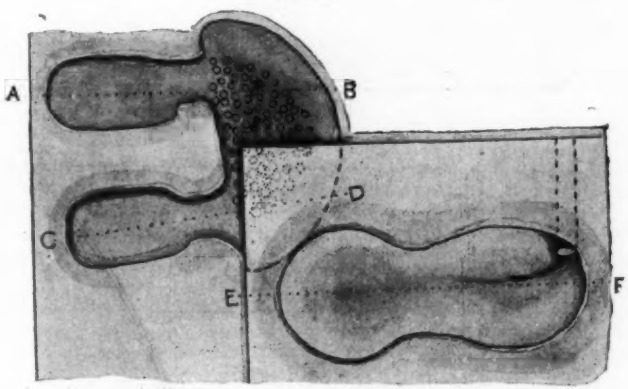

FIG. 4.—DOUBLE FURNACES AND IRON-SMELTING HEARTH.—II.

Smelting Hearth No. II.

The base of another rude iron-smelting hearth (see Figs. 4 and 5) was situated on the north side of the fortification, about midway between the east and west ramparts and 21 ft. from the inside edge of the main Via. It was upon the middle surface of an oblong massive clay platform from 1 to 1½ ft. thick, uncovered at 1½ ft. below the grass,

Carbon, combined	0.060
Silicon	trace
Sulphur	0.027
Phosphorus	0.037
Manganese	trace
Iron, by difference...	99.876
	100.000

* Sussex Archæological Society's Collections, Vol. XLVI.

In his opinion this specimen was a pure variety of soft iron made from magnetic ore or red hematite, and purified from cast iron, as such a low percentage of carbon would have been practically impossible if made direct from the ore in this rude furnace.

Many lumps of heavy slag were scattered up and down in the ash-blackened stratum surrounding this and a number of other adjoining furnaces. One of the lumps was basin-shaped, about 6 in. across, and so heavy and rusty as to be taken for a mass of iron, until analysed by Mr. Ruddock, who found it to contain:—

Ferrous oxide	51.80
Ferric oxide	6.73
Manganese	.26
Alumina	5.20
Lime	3.00
Magnesia	1.17
Silica	28.07
Phosphoric acid	.43
Sulphuric acid	.19
Organic matter and water	1.70
	98.55

"The large amount of alumina shows that it was made from clay ironstone."

Iron Smelting Furnaces No. III.

In 1902 an interesting discovery of iron-smelting furnaces was made at Stockton Heath, on land leased by Mr. C. W. Davenport, and excavated by his kind permission, situated on the east side of the Via, just opposite to the ore-roasting ovens described below. The traces of workshops started at 22 ft. from the Via, and extended 50 ft. from east to west by about 57 ft. from north to south. The further (eastern) end of this area was covered by an additional floor of very dense clay, oval in shape (diameters 16 ft. by 12 ft. 6 in.), and slightly domed, in the surface of which the furnace cavities were sunk.

These cavities were three in number, and nearly semicircular, 2 to 3 ft. in diameter and 6 to 8 in. deep, with sloping bases, like a horse's footprint—so formed to collect the molten metal for ladling. A funnel-shaped sloping trough (2½ in. deep, and from 10 in. to 5 in. wide) across the front edge of one of these cavities at its deepest part, also served for drawing off a lighter liquid, probably slag, and collecting it in a depression purposely provided at its extremity. In the base of one of the cavities was a square hole for a purpose which was not recognised.

The "finds" in the vicinity, though few, are of unmistakable significance, so that "he who runs may read."

Coins.—Several coins were lying together nearly in line about half way between the paved courtyard and Via, 2 ft. below the grass, viz., five silver denarii (one each of Domitian and Trajan, two of Hadrian, and one corroded), one first bronze of Hadrian, and two second bronze corroded.

Round about the floor were 35 lumps of iron slag, one each of hematite, ruddie,

Sections.

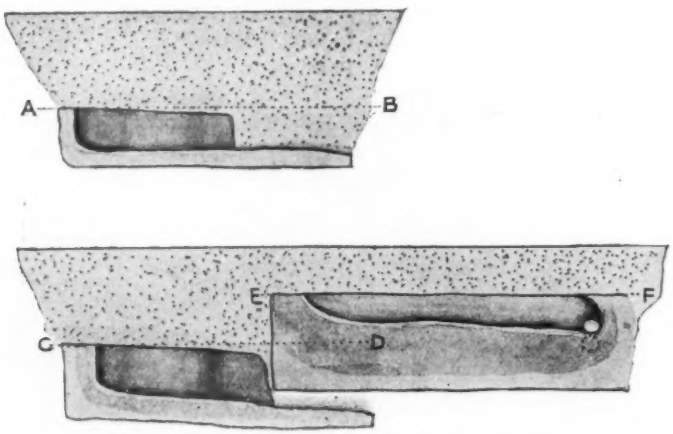

Fig. 5.—Double Furnaces and Iron-Smelting Hearth.—II.

and clay-band ore, two pieces of ordinary mineral coal and one of cannel, and many iron nails 2 to 5 in. in length.

A large stone mortar for pounding ore was met with 2 ft. down and 30 ft. north-west from the furnaces. The stone itself is roughly hemispherical, 2 ft. 6 in. across the top, with the hollow bell-shaped, 10 in. wide by 7 in. deep, the inside of the latter being worn smooth on one side by pounding, and the surface of the stone deeply grooved in one direction by the sharpening of points, a practice which was very prevalent in Roman settlements.

From the number of furnaces and the quantity of ore and slag there can be no doubt that a rude method of iron smelting was practised on this spot. The only question arising is, therefore, which of the many metallurgical processes known to the ancients or still practised by primitive races was employed?

The easiest and simplest, and probably the earliest, method is that known as the direct or "Catalan" process, whereby pure hematite ore is heated a few hours with a charcoal fire in a mere hole in the ground, and a blast from hand bellows introduced over the top and maintained until the metal is reduced, when it is forged at a red heat and without melting.

At Wilderspool two kinds of furnace existed, viz., a smelting furnace and a purifying or "smithy" furnace, and the shape and solidity of the former suggested that continuous working was practised.

In the shallow cavities now being considered there is no possibility of continuous working, and since impure clay-band ore was chiefly employed, as is clearly proved by the analyses of the slags, this implies that the powdered ore from the opposite ovens was mixed or spread in layers alternately with charcoal, ordinary mineral or cannel coal, inside the cavities, and a blast from bellows introduced over their edges maintained until the mass was actually melted. The slag could then be skimmed or run off through the little trough provided, apparently, for that purpose, as it sloped downwards and narrowed towards the outside, and there was no tap-hole provided for running out the iron from beneath as in modern blast furnaces. The crude or cast iron could be gathered at the bottom or ladled into moulds ready for re-heating in a fining or smithy furnace and welding into blooms.

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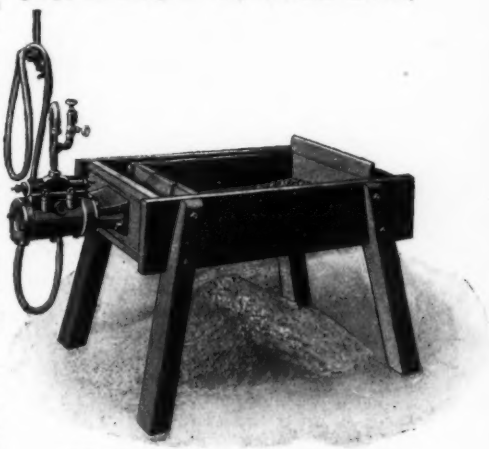
LACY-HULBERT & COMPANY, LIMITED, have removed from 25, Victoria Street to 91, Victoria Street, Westminster, S.W.

THE BATTLE CREEK SAND SCREEN.

THE annexed cut shows a sand screen operated by steam or air. The size of the screen is 18 in. by 30 in., and the weight 150 lbs. This sifter is strong and substantial to withstand the severe usages to which all foundry equipment is subjected, and is operated by a powerful little engine, either by steam or air, and can be regulated to run fast or slow as desired by simply adjusting the throttle valve, and after starting will run continuously without further attention. The screen or screen-box can be instantly removed for cleaning without disconnecting any of the parts. It is claimed by Messrs. J. W. Jackman & Company, Limited, of 39, Victoria Street, S.W., who are the agents for the sale of the machine, that it is plain and simple, and that one man can sift more sand with the Battle Creek Sand Screen than eight men with the old time crank sifter.



THE BATTLE CREEK SAND SCREEN.

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THE following liens have been registered during the month:—Diesel Engine Company, Limited, £15,000 debentures; William Gray & Company, Limited, shipbuilders, West Hartlepool, £350,000 debentures; C. H. Johnson & Sons, Limited (wiredrawers, Manchester), £700 third mortgage debentures; Bolckow, Vaughan & Company, Limited, £86,300 debentures; North Wales Iron and Manganese Company, Limited, Liverpool, £2,250 7½ per cent. debentures.

MOULDS FOR STEEL CASTINGS.

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—The article under the above heading in the May issue of your journal was read by me with a peculiar interest, especially the reference to the moulding of a dynamometer pulley for casting in steel. I am in entire agreement with the remarks of Mr. Peters regarding the fact that steel is superseding malleable. There is no doubt that the time taken up, and the cost of annealing malleable castings, are a serious hindrance to the cheap and rapid production of the same, and users and makers alike are now becoming keenly alive to the necessity of availing themselves of the speediest methods, combined with absolute reliability, by which they can obtain the various castings they require. However, the cause of my intervening at this point is to point out one or two very obvious errors into which your correspondent, Mr. Peters, has fallen regarding the moulding of the dynamometer pulley above mentioned.

Firstly, he states that a round plate was rammed up in the core, whereas in reality a core grate was used, the advantage of which over a plate will at once be noted in the easing of the core, which operation took place immediately after the cast.

Secondly. Your readers will notice the runner (see Fig. 7) is on the plated side of the pulley. Such an arrangement would not be practical, either for iron or steel, as the plated side must of necessity be as clean as it is possible to obtain it; in fact, the thoughtful moulder would not attempt to run such a casting in the manner described. To do so would have spelt failure, and the mould was, in reality, cast the other way up. The construction of this pattern, if your readers will study the same, will show how impossible it would be to deal with it as shown in the Fig. 7, already quoted, the result of which would have been that upon the wheel being taken out of the sand it would have been found twisted, through the expansion of the core and nothing in the bottom part to prevent the opening of the casting when cooling; for, as will be noticed, the grooved part is very thin, whilst the boss is very thick. Taken altogether the article is a very fair description of what turned out to be an exceedingly interesting and useful experiment, and, so far as the saving in pattern-making was concerned, too much praise cannot be given. To make the whole quite complete I felt bound to drop in the explanations given above, which I am sure my friend will accept in the best spirit.

Yours, etc.,

JAMES J. CHIPCHASE.

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MELTING STEEL WITH CAST IRON.*

BY R. P. CUNNINGHAM.

THE demand for castings to stand great strength has increased to such an extent that foundrymen are often at a loss how to produce castings up to the required specifications. The manufacturers who are the most often called upon to produce castings of high strength are pump and engine builders, and tool makers.

To-day it is nothing uncommon to get an order for a pump to work under a pressure of 5,000 lbs. and even higher. Engine builders are called upon to build engines to work under 200 lbs. steam pressure. The speed that the modern tools are run at to-day is nearly double that of a few years ago.

Anyone familiar with pump work will readily understand the necessity of having a perfect casting, not alone smooth and true to pattern, but clean, close grained, yet soft enough to machine easily. Many castings go through the machine shop and erecting room, but fail when put under test. By adding a percentage of steel scrap we have in a great measure overcome this difficulty if the trouble is caused by porosity of the metal.

When melting steel with cast iron there are many things that require close attention in order to obtain the very best results. In charging the cupola one cannot be too careful and should be absolutely certain that all the material called for in the charge is put in. The weight of each material specified should be correct; the fuel and fluxes should be analysed so that the exact composition of all the materials going into the iron to be made may be known. In making high grade metal we have to contend with the impurities of the fuel and fluxes charged into the cupola, besides that we have estimated on in the metal.

A high percentage of steel necessarily increases shrinkage, demands closer attention, requires more rapid handling in the foundry, and, when very high, tends to make all the operations connected with it draw away from those of a cupola metal and approach that of a steel casting.

* Abstract of paper read before the American Foundrymen's Association.

When this extreme point is reached melting in the cupola becomes very unsatisfactory.

The average thickness of a casting bears a relation to the percentage of steel desirable. For thin castings only a small percentage can be used, while for thick heavy castings a large percentage is permissible. This is so because a thin casting has no self-annealing power on account of its rapid cooling and the chilling effects of the mould. The thicker casting, on account of its slower cooling, anneals itself somewhat, and opens the grains of the metal perceptibly. The same metal in a thin casting, which is hard, would be quite soft in a heavy casting. My opinion is that it is more desirable to have a mixture with the smallest percentage of steel that will give sufficient strength and solidity to the casting for all practical purposes.

The author's method of charging a cupola is as follows:—Let us say that we want to make a casting which will require 4,000 lbs. of metal, with 25 per cent. steel. With a cupola that lines up 48 in., we put on the bed 1,200 lbs. of coke, on top of this put 1,000 lbs. of iron, then 500 lbs. of steel, then 500 lbs. of iron, then 150 lbs. coke, 500 lbs. steel, 1,500 lbs. iron. The coke next above the metal charge should be greater than between the ordinary charges, and the pig-iron in the next charge above the steel should be of the same chemical analysis as the iron used in the steel, so that if any metal should melt and run into the steel it will do no harm. With the last amount of steel we add 1¼ lb. of ferro-manganese to every 100 lbs. of steel used. We also put the same amount of ferro-silicon into the ladle. This should be done after the first metal has been drawn into the ladle. This metal should be poured as soon as it becomes quiet in the ladle.

If the casting is uneven in thickness attention must be given the shrinkage. Setting a riser on the heavy parts and after the mould is full pouring slowly until the riser is full obviates trouble. If the casting is very heavy it will be necessary to feed it, but an ordinary casting will not require this.

We have found by using two brands of iron, one high in manganese and the other high in silicon, both low in sulphur, that we can get a much finer grained casting, with more elasticity, than we could if we depended on ferro-manganese and ferro-silicon to bring these two elements up to the desired percentage. We reason it in this way:—If the manganese and silicon are in the pig they are more evenly distributed than when they are put into the cupola and depended upon to become thoroughly mixed in it or in the ladle. We have never yet depended upon the pig for the entire amount of manganese or silicon wanted, but have added each in the proportion given above.

We sometimes have trouble caused by wrought scrap or hard steel becoming mixed with the steel scrap. In either case satisfactory results cannot be obtained. With hard steel there are hard spots in the casting, while wrought iron increases porosity, which is very bad if the casting is uneven in thickness.

Mixtures of this kind will in future be used to a greater extent than they have been in the past because the demand for this class of castings has increased. The result of eighteen casts with different percentages of steel showed that the highest amount of steel that could be used to an advantage is 33 per cent. Above this it showed excessive shrinkage, and only a slight gain in strength. The highest point reached for tensile strength was 33,205, the lowest 31.890 for perfect bars. The highest transverse strength shown was 3.335, the lowest for a perfect bar was 3.180.

For ordinary work 25 per cent. steel will give sufficient strength for all practical purposes, will machine easily, and yet be close grained.

—o—

A somewhat serious fire broke out recently in Cardiff, and involved the premises of John Williams & Sons, Limited, engineers and ironfounders. We understand that the loss is covered by insurance, and that a minimum of inconvenience has been caused.

Joseph Wright & Company, of the Neptune Engineering Works, Tipton, are supplying one of their patent multiplex heater detartarisers to Messrs. Steel, Peech & Tozer, of Sheffield, to heat and soften 10,000 gallons per hour. The firm have also just supplied Guest, Keen & Nettlefolds with a large size Berryman heater for their Dowlais Works.

Babcock & Wilcox, Limited, recommend a distribution out of the reserve fund of £265,000, at the rate of 10s. per share, to the holders of ordinary shares, while at the same time 265,000 ordinary shares of £1 each are to be offered to the shareholders at par, in the proportion of one new share for every two ordinary shares held.

CARE AND STORAGE OF PATTERNS.*

By H. M. Lane.

One of the most serious problems that confronts any manufacturing concern is the storage of patterns and the records for the same. All patterns are to be divided into two classes—wood and metal. If the concern uses metal patterns entirely the storage can be much simplified, as the metal patterns can be easily protected against fire loss, and hence the storage of this class of patterns will be considered first.

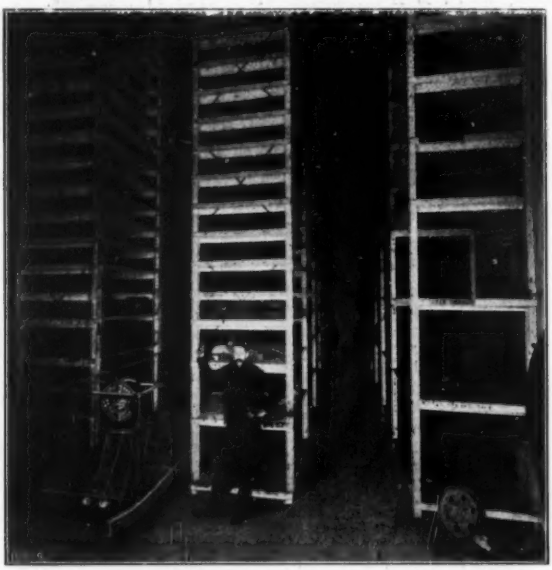

Fig. 1.—Foot of Pattern Shelving, showing Hoist: Individual Vault System.

Metal patterns are, as a rule, of comparatively small size. Very small or thin patterns, which are used in connection with match plates, can be stored in fireproof vaults or rooms. Very frequently, however, wooden shelving is used in such vaults, though when possible it is always to be avoided. Very strong, and not exceedingly expensive, shelving can be made up from light angle iron and sheet iron. It is needless to say that the pattern vault should always be kept dry for the protection of patterns, and under such conditions the iron shelves and supports would last almost indefinitely. A vault of this kind having fireproof walls, roof, and door, and provided with metal shelving, is undoubtedly the best possible arrangement. To cheapen the arrangement somewhat, many have substituted wooden shelving for metal shelving. If the vault is thoroughly fireproof and there is no opportunity for the shelving to be set on fire, such a vault is certainly very valuable; and it is probable that the risk of fire from the shelving is almost a negligible factor.

To still further reduce the cost of the storage some manufacturers have located the storage in a building apart from the other structures, and arranged with no windows in the side walls. The shelving is of wood and the roof of some slow-burning construction, usually covered with slate or metal. Light is obtained from sky-lights in the roof. Such an arrangement as this is undoubtedly a great protection, but care should be taken not to store combustible materials in the vault, such as alcohol, gasoline, etc., as the ignition of a can of such material might destroy the contents of a vault in a very short time. If no such building is provided for the metal patterns the stor-

* Paper read before the American Foundrymen's Association.

age shelves should be so arranged that they can be readily protected by a fire-fighting apparatus, and they should also be located in some part of the plant where the fire risk is a minimum.

As a rule, where metal patterns are used in stove plate, hardware and similar

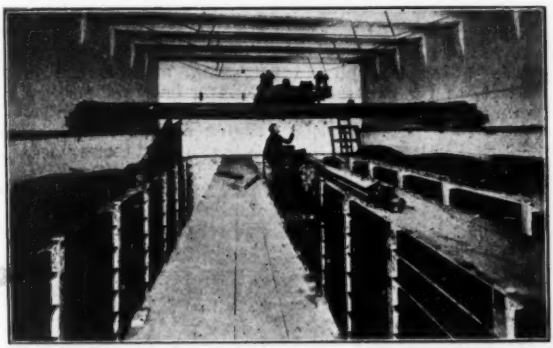

FIG. 2.—TOP OF PATTERN SHELVING, SHOWING CRANE WITH CAGE ON HOIST: INDIVIDUAL VAULT SYSTEM.

factories, the patterns with their matches do not take up much space, and hence a very large number can be stored in a comparatively small space. Where special moulding machines, equipped with large patterns, are used, it becomes necessary to provide stronger and larger shelving,

bulky than metal patterns, and hence require larger space in the storage; third, wood patterns absorb moisture during moulding to a greater or less extent, and if they are then placed in a cold storage room, in the winter moisture freezes and injures the joints and surface of the pattern, and hence a pattern storage for wood patterns should be provided with some heating system. It is also necessary to heat the metal pattern storage for the benefit of the man who takes care of the patterns, as no man can do work in a cold room.

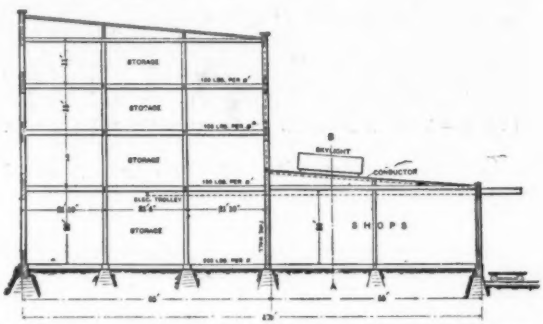

FIG. 3.—SECTION OF PATTERN SHOP AND PATTERN STORAGE; INDIVIDUAL ROOM SYSTEM. (BUILDING IN CONCRETE FIREPROOF CONSTRUCTION).

and in some cases the large pieces must be kept on the floor of the storage building.

In the storage of wood patterns, several very different factors enter to complicate the problem. First, the patterns themselves are highly inflammable; second, wood patterns are usually very much more

In the case of wood patterns all that can be done in the construction is to minimise fire risk. Different parties have taken different methods for accomplishing this. Among the methods of construction of pattern storage buildings in regard to fire risk the following may be considered:—First, in regard to protection there are

the individual room and the individual vault systems. In the first ordinary pattern shelving is used, the rooms are provided with fireproof floors, the windows, if any, with fireproof shutters, and the doors with self-closing fireproof doors; these doors are held open with cords and fusible plugs or couplings which would be released very quickly if exposed to any heat. The object in this system is to prevent the fire's spreading through the entire storage and to, as far as possible, smother the fire in the compartment in which it breaks out. This system is generally used in connection with the sprinkler system. Of necessity the pattern shelving is not very high in such a storage room, on account of the fact that the patterns are all placed in position by hand from short ladders, and hence the

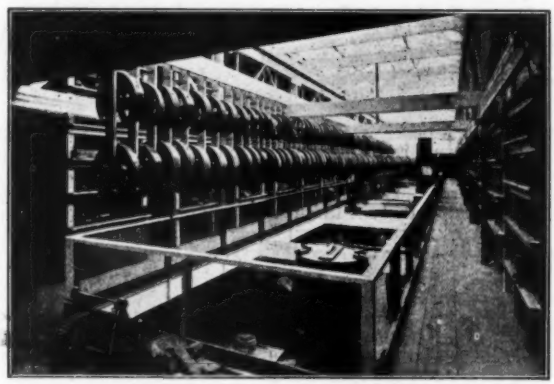

FIG. 4.—A GOOD METHOD OF STORING GEAR PATTERNS.

individual units are rooms from 60 to 100 or more feet in length, usually from 60 to 80 or more feet wide, and from 15 to 20 feet in height.

In the other system the individual rooms or units are made narrow but very high; a crane is used for placing the patterns into or taking them from the storage, the crane being arranged to travel over the entire room so that the operator may carry his cage or platform in between any of the sets of shelving, and thus reach any point of the storage system. Such rooms can be made practically air tight, the ventilators at the top being provided with covers suspended by fusible couplings which are dropped at the least indication of fire. In this style of storage the sprinkler system would be of little avail.

In both the systems so far described every possible precaution is taken to enable those in charge to extinguish fire, should one start; usually, however, these buildings are arranged for use of artificial light, which in most cases is furnished by the use of incandescent lights. Such wiring naturally introduces fire risk. To minimise such fire risk and at the same time to reduce the labour of placing the patterns on or removing them from the shelving, at least one prominent manufacturer has constructed a pattern storage using slow-burning mill construction and having a head room not exceeding 8 ft. so that a man standing on the floor could reach any of the shelves.

To minimise fire risk no artificial lights of any kind are allowed in the building, and all patterns are taken into or out of the storage during the day.

Other manufacturers have sought to minimise the fire risk in many ways. In some cases the inflammable character of the material has been recognised and only a thin wooden roof of light construction used; the idea being that such a roof would burn off quickly and give free access to the fire for the firemen. A large number of pattern storages have been constructed one or two storeys in height, without any outside windows, all of the light being derived from a skylight, the idea being that the lower part of the building could be shut up tight and a fire smothered out. The particular form of construction of the building must of necessity depend largely upon the means of the company owning the plant, and where sufficient capital is not available it is often necessary to use the simplest kind of frame structure. There is no place

about a manufactory where there is such an opportunity to display fads or ride hobbies as there is in connection with the care and storage of patterns, and it requires good judgment and careful planning to be sure that the best system is installed. There are a few points in connection with the subject of pattern storage, however, which may be called axioms.

First, no matter how many men are allowed to take patterns from the storage, only one man should be allowed to return them, and he should be held responsible for every pattern. Second, where only a limited number of small or medium-sized patterns have to be cared for, it is foolish to instal any hoist or elevator system for handling patterns, as in most cases the attendant has ample leisure to put them away, and in many cases he can carry them upstairs cheaper than they could be taken up on an elevator, which would ordinarily stand idle 99 per cent. of the time.

Third, whatever system is in vogue, some provision must be made for taking care of the dead patterns; in other words, there must be a graveyard.

Fourth, wood patterns must never be stored where they are subject to rain or snow, or even where they are subject to freezing temperatures. The reason for the latter statement is that moisture in the surface of the pattern will be frozen and injure the surface or finish. This freezing will also often open the joints.

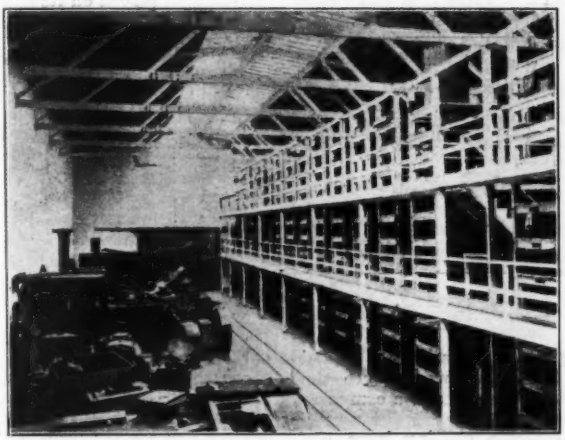

FIG. 5.—PATTERN STORAGE WITH LIGHT WOODEN ROOF AND SKYLIGHTS.

THE EFFECT OF MANGANESE IN LOW SILICON CAST IRON.

A PAPER read by Mr. H. C. Loudenbeck before the American Foundrymen's Association describes some tests made to show the effect of manganese on the chill and fracture of cast iron having a low percentage of silicon. The mixture was melted in a small test cupola having a diameter of 16 in. inside the lining. The blast pressure was 6 oz., and the size of chilled test pieces was 3 in. by 4 in. by 10 in. These were chilled on the edge, or the 3 in. by 10 in. face. Test pieces were also cast in the sand to determine fracture and also to obtain drillings for test.

The test indicates:—First.—In cast iron having from .50 to .70 per cent. silicon, the addition of manganese above 1.38 per cent. gradually hardens the metal, the combined carbon and the chill increasing with the addition of manganese. The above statement should be modified, for when smaller or larger castings are made the size of the casting has a marked effect on the cooling of the metal and in that way affects the carbon.

Second.—When the manganese is high and the casting large enough to be grey, the fracture is open and coarse, and the graphite scales very large and crystalline.

Third.—High manganese, to a certain extent, prevents absorption of sulphur from coke.

When the manganese is below 1.38 per cent. (this percentage is only approximate and depends largely upon the percentage of silicon present) the lower the silicon the sooner the manganese will commence hardening, with iron its action is different; it softens iron, lowers the combined carbon, and decreases the chill; this effect is more marked where the sulphur is high.

The conclusions arrived at may be briefly summarised as follows:—Manganese can be used to an advantage in low silicon and chilling iron in the following cases:—In mixtures where the percentage of scrap is large and the sulphur necessarily high, the result of this increase in manganese would be lower sulphur, lower combined carbon, less chill and greater strength.

Very often chilled plates are required, having hard chilled faces and soft backs suitable for planing. Manganese added in the right proportion will reduce the tendency to mottle, and make a comparatively soft graphite back.

In all cases where chilling irons are melted in a cupola and the sulphur is over .07 per cent, the iron can be strengthened by the use of ferro-manganese or pig-iron having a high percentage of manganese.

There are some cases where the manganese should be kept low. In the manufacture of large hydraulic cylinders it is necessary to have a close mottled iron to withstand the pressure and prevent leakage. If the manganese is too high this mottled structure is replaced by a coarse graphitic structure, which is not satisfactory for this class of work.

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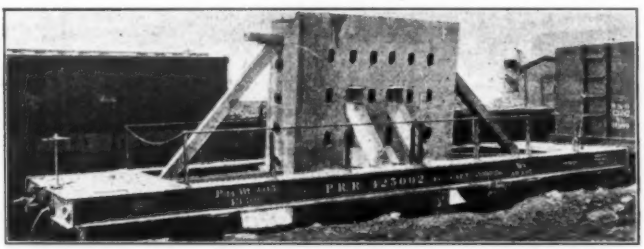
THE CHAIN BELT ENGINEERING COMPANY, of Derby, are supplying the Alquife Mines & Railway Company, Spain, with an unusually heavy conveyor and elevator for handling iron ore briquettes.

LARGE STEEL CASTINGS.

THE AMERICAN STEEL FOUNDRY COMPANY has recently completed what is said to be the largest and heaviest steel casting ever made, to be used in building pier No. 1 of the Blackwell's Island Bridge, which will span the East River between New York and Brooklyn. The American Steel Foundry will make 32 of these steel castings to complete the order. When the order was received it was at once decided to have three special cars built to transport these immense castings to New York. These cars will be loaded to within 6 in. of the top of the track rails.

The accompanying illustration shows the first steel casting, weighing 90,760 lbs., placed on its side on board the car ready for shipment. This casting measures 12 ft. 2 in. by 12 ft. 2 in. at its base, 8 ft. 5 in. by 10 ft. 5 in. at the top, and is 3 ft. 9 in. high. The thickness of the metal throughout the casting is $2\frac{3}{4}$ in. The centre or body of the casting is formed of the frustum of a pyramid, with ribs connecting the top and bottom plates, and the inside of the casting is a network of ribs. The top and bottom plates are plain and have oblong holes for the purpose of removing the cores from each individual cell of this network; 60 holes have been drilled in the top and 32 holes drilled in the bottom plates for construction purposes. This steel casting is to be placed on top of two other steel castings, which have already been cast and bolted together, and another casting will be placed on top of the casting shown in the illustration.



A LARGE STEEL CASTING.

To make a steel casting weighing 90,760 lbs. involves an immense amount of labour in making the moulds and in the setting of the cores, nearly every one of which is set at an angle two ways, and

it is only by very skilful handling that good results can be obtained. The moulds have also to be carefully secured in order to withstand the enormous pressure while the metal is being poured into them. The metal in this steel casting was poured from three ladles and was the product of three furnaces.

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CONTINUOUS CAR WHEEL MOULDING.

With reference to the description of the continuous plant for moulding car wheels, described in the Foundry Trade Journal for June, Mr. G. K. Hooper writes :—

To enable this plant to be classed at all with modern foundries on this class of work, it should, in the first place, have its moulding done upon continuous moulding tables, supplied with sand from overhead hoppers, the finished moulds then being conveyed to cupolas to be poured, thus saving time, labour, and space, and enabling the utilisation of labour to its best advantage at one operation all day long. Such continuous systems are in gradually increasing use in America, and produce a large increase in capacity, both for a given amount of floor space and a given number of operatives. Such a continuous system would provide as well for the separation of the various operations, instead of having them piled over one another as in this plant, and by the localising of them each in a separate place, enable each to be handled in quantity and to best advantage.

The plant as described uses one moulder and two helpers for the production of 25 moulds per day, or a production of 8 1-3 moulds per operative, while with a continuous moulding table one moulder with six or seven helpers would probably produce about double that number per operative, with a lower average wage rate and an economy in space and investment, since the number of patterns necessary would decrease proportionally to the increase in production.

Of course, such a system requires ordinary labour at various places for handling, etc., but my experience is that, even counting in such additional labour and including the necessary power house labour, the production per individual engaged is about 10 to 12 per cent. greater than when working as in the plant which you have described.

Continuing the comparison further, such a continuous system would enable at least one pair of cupolas, with a second pair as alternates, to pour the whole day's production, thus doing away with 50 per cent. of the charging labour and investment in melting equipment made necessary by the arrangement which you describe, and making a considerable decrease in the amount of space necessary for melting, as well as in equipment necessary for handling the coke and iron, and enabling this to be done in one place, instead of being scattered over three places.

Imagine, now, such a system in operation and the mould completed on such a continuous table as I have mentioned; it would then be transferred to a conveyer which would carry it to the cupolas, where it would be poured in transit. It would then proceed on this conveyer such a length of time as is necessary for it to cool sufficiently to bear handling, when it would be thrown off on a separating grid, where the flasks would be shaken out and thrown on a conveyer which would carry them back to the moulding tables. The sand would fall on a conveyer which would carry it to riddling apparatus, where it would be cleaned of shot, sprues, rods, etc., and it would then, while in transit, be tempered and riddled sufficiently to thoroughly mix it, and then fall on a conveyer which would carry it back to the moulding tables. Contrast this with the shaking out, riddling and tempering of the sand on the floor where it is to be used, at an enormous waste of room and labour, to say nothing of the inconvenience of working around moulds and patterns and of tempering separate piles of sand, with the undoubted lack of of uniformity which such work entails. Such a continuous system would, by the use of three men, handle all the sand for the whole production claimed for this foundry.

Going further, the shaken-out wheel be taken up on a conveyer *en route* for the annealing ovens, and the surplus sand sticking to it knocked off over a trough in which runs a conveyer which would take this sand to unite it with the main body of sand. While still in transit, and over another trough, the core would be knocked out, a conveyer in this trough disposing suitably of the core sand, and at a convenient moment the sprue would be knocked off to fall on a conveyer carrying it back to the cupola.

This method provides for the immediate removal of the product from the scene of the last-performed operation without waiting upon or depending upon three other operatives, as in the plant which you illustrate, thus doing away with three chances of delay. It is unwise to as-

sume that four men can all work at the same speed, in addition to which the plan of handling four pieces at a time presupposes perfection in the working of all of the operations and apparatus up to this point, which is a manifest impossibility.

The handling of a number of pieces at a time also removes any possibility of increasing the efficiency of the labour employed, since the slowest gang sets the pace in each group of four, instead of the fastest individual setting the pace, as in the method which I describe.

The wheels would then pass to the annealing pits, into which they would be lowered, these pits being much closer together than those in the foundry that you describe, they not being dependent upon the spacing of the floors, and being, as well, all in one place, instead of two, a saving is gained in room and in the putting all of the annealing and, incidentally, the cleaning in one place, and hence each under the eye of one foreman.

In all probability considerable space could be saved by making the inclosing building a two-storey building, with the moulding and casting in the second storey and the cleaning, boring, mounting and grinding, if any, in the first storey.

As a summary of the advantages of such a system as I am outlining—and it is a modern one, there are:—

1. Continuous operation of the labour, skilled or otherwise, at one task for the whole day.

2. The putting of each operation in a distinct place by itself, and not mixing it up with other operations in any one place, thus leading to economy of space and increase of production.

3. The greater continuity of the work, due to the absence of the necessity of stopping one operation that another may be performed.

4. The locating of the annealing and cleaning each in one place, instead of being sub-divided, as at present, with a consequent reduction in cost in handling equipment, greater efficiency of labour, and lessening of cost of superintendence.

5. A saving of about 50 per cent. in melting equipment, and of considerably more than 50 per cent. of space for melting.

6. The saving in labour, in handling, and tempering sand.

7. The saving in investment in patterns, due to the considerably greater capacity of continuous moulding tables.

8. The saving in moulding space, due to greater capacity of continuous moulding tables over ordinary floors.

9. The saving in quantity of skilled labour, due to the greater capacity of continuous moulding tables, with consequent reduction of average wage.

10. The greater efficiency of all labour, due to the continuity of the operations, this amounting to at least 10 or 12 per cent.

11. The saving in space in annealing, due to the lack of need of conforming the construction of the annealing ovens to any other part of the plant.

12. The ability to develop the efficiency of the individual skilled labourer by freeing him from the necessity of waiting upon his fellow operatives.

13. Considerable saving in the labour and space necessary for distributing cores.

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THE FRODINGHAM IRON AND STEEL (FOREIGN AND COLONIAL) COMPANY LIMITED, has been registered with a capital of £5,000 in £5 shares, to adopt an agreement with the Frodingham Iron and Steel Company, Limited, and to carry on the business of ironmasters, etc. The registered office is at Frodingham, Lincolnshire.

FLOCKTON, TOMPKIN & COMPANY, LIMITED, were recently exhibiting at their Newhall Steel Works, Sheffield, some turnings made with the "Cat" brand of high speed steel. In mild steel a 4¼ in. diameter hole 10 in. deep was drilled in ten minutes; a 3½ in. hole 4 in. deep in two minutes; a 2½ in. hole 3¾ in. deep in one minute; and in cast iron, a 1 in. hole 6 in. deep in one minute.

MR. EDWARD WHITE, of the Windsor Works, Redditch, has purchased the patent rights of Mr. C. W. Coleman for his invention of pattern plate apparatus, and Mr. White will now manufacture the apparatus at Redditch. Mr. W. Littleton, of 9, Fenchurch Street, London, E.C., has been appointed sole agent for London and the South of England for the sale of this apparatus.

THE contract for supplying steel rails and fish-plates to the tramway department of the City of Birmingham has been divided between Bolckow, Vaughan & Company, Limited, who have received an order for 1,650 tons of rails and fish-plates, at £5 10s. per ton, and Hadfield's Steel Foundry Company, Limited, who are to supply a considerable quantity of special type tram rails.

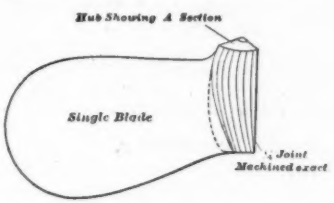
MOULDING A PROPELLER WHEEL.

By A. M. Loudon.

The present era demands from every foundry owner castings at the lowest cost. To turn out the orders and keep the cost on the right side of the ledger foundry foremen are often taxed with phenomenal propositions. As many foundries in this country make propeller wheels of varying dimensions, and as there are so many different ways adopted to make them, I have taken this opportunity to bring before the notice of foundry owners and foremen what I consider the best method. Many are daily making these castings under some other method, which costs much more and does not secure as perfectly balanced a wheel as the method described.

Through the kindness of Thomas Sherriff, of Milwaukee, the writer had the privilege of photographing the rigging herein described for the making of the wheel moulds, together with the opportunity of seeing a 10-ft. wheel, four blades, moulded and closed to cast, and could have seen the casting but had not time. This mould was made in dry sand by two moulders, and from the time the first cope was laid on the floor until the iron was poured into the mould the time elapsed was thirty-two hours. Now I fancy I can hear some of you laugh at this statement, but I believe that if some of you here that are interested in the manufacture of propeller wheels would follow the method applied in that little foundry in Milwaukee, you would be convinced that it is about time that you quit the old-fashioned way of sweep and loam mould.

I have included a sketch of a blade with a perfect quarter hub, as shown in Fig. 1. To begin with the moulding the cope is laid down anywhere on the floor filled with sand and rammed ordinarily, then shovelled off to the sweep of the flask. The pattern is then laid on the sand made solid, the nowel is then put on and facing sand riddled on. The sand is shovelled on to a convenient depth and rammed, repeating until ramming is completed; the excess sand is shovelled off and butted, two wood screws are inserted into the pattern and secured to lift pattern and save moving cope; the nowel is then lifted off, rolled over and set down handy to the heap on a bed, the joint is made, one of the other copes is then put on and rammed up as on an ordinary dry sand mould. The joint around hub is made perfect, shaving off one-eighth inch of the total depth of hub, leaving the sand containing print and under full size of pattern for an exact circle when closing up. The cope is lifted off pattern, drawn and placed back in false cope which was first used. The second blade is then rammed up as the first, using the same precaution for hub joint, then the third. Next the fourth nowel is rammed up, joint made and false cope shaken out, as it is no longer required for any other purpose, the cope being rammed up and joint made as the other three were, cope is lifted off, pattern drawn and put away; on account of two moulders working on this with a helper, when the last blade is rammed up the other three blades are finished ready for the oven, and in a very short time the fourth is completed, the car loaded and put into the oven, where it is



baked in one night. Next morning a level bed is struck off on a special part of the floor with a ring bedded on it. The flasks are then taken from the oven and brushed off, each cope going on the nowel it was rammed to anywhere on the floor. The first blade is then placed on the bed and a plumb level is used on the joint of the hub, which sets the blade exact pitch and level. The second blade is then placed on bed, using the joint of the first flask and the plumb level on the opposite joint and so on with the other two. The last one is set by size sticks which bring the hub to a perfect circle, and the quarters being true uprights, secures the wheel spaced to with one-quarter inch of exact quarter circle each. Then the moulder who closes the mould, as there is only one doing this job with the helper, fixes up the hub joints while the helpers get the curbing around the flask and ram it up, covering the hub with a cake core and secured with cross bars and wedges. He can easily get his mould ready by two or three o'clock.

Read at the New York meeting of the American Foundrymen's Association.

THE DEFECTS IN MILD STEEL CASTINGS.*

By Professor K. Hermann Wedding.

Mild steel castings have the advantage over wrought iron in being free from slag, but they have the disadvantage of enclosing gases which form cavities upon solidification. They are generally made either in the open-hearth furnace or in the crucible; seldom in the converter. In general, one may assert that those which are cast from the crucible possess the best qualities, while those from the converter are the least desirable. This arises from the fact that the chemical composition of steel can be more exactly regulated in the crucible than in the converter, and that the crucible process is the one by which the gases can be most easily and most completely expelled from the iron, while in the converter process, whether acid or basic; this offers the greatest difficulty. In respect to the cost, the most expensive castings are those from the crucible, the cheapest those from the converter. It will be easily understood, therefore, that the middle way is most often chosen and the open-hearth employed for the melting of the iron used for the manufacture of ingot-iron castings. Hence, special consideration will be paid to this process.

Blow Holes.

All carbonised iron can absorb gases. These gases are frequently united with the molten metal into a fluid alloy, but upon solidification they behave differently. They may (1) remain alloyed, (2) be retained between the crystals, (3) escape into the air if they be given the opportunity, or (4) remain imprisoned in the solidifying metal, forming small cavities or blow holes.

In general, the rule holds that the hotter the molten metal, the more quickly will it absorb the gases, and that the more quickly it solidifies, the more gases it will retain. The absorption of the gases can, therefore, be avoided, or, at least, diminished, by protecting the metal during melting from the influence of gases, and by treating it in the same way when it is poured; or efforts may be made to expel the enclosed gases. For this reason crucible cast steel contains the smallest amount of gases. For this reason, also, drying the air which is blown in the Bessemer converter would be advantageous, and likewise, to keep out the hydrogen a layer of slag in the open-hearth furnace should be effective. Besides this, the moulds must be filled so as to exclude air as much as possible.

Enclosed gases can be expelled by a slow cooling of the molten metal. This procedure is adopted both with crucible and open-hearth steel. Another means is the stirring of the molten metal.

Besides these means, which naturally effect only the expulsion of the gases not chemically united with the metal and not those alloyed with it, means may be employed which hinder the evolution of the gases by causing them to remain alloyed with the metal. For this purpose silicon and aluminium are especially useful.

The gas most frequently enclosed and in largest quantity is hydrogen, and the two elements named act on it as just stated. Manganese, on the contrary, lessens the power of the metal to retain the gases, causing a quicker escape of the gases separating from it upon solidification.

Since steel poured in a mould solidifies first at the contact with the mould, the escape of the separating gases is very soon prevented; and they form, as far as their tension permits, small cavities in the interior of the metal.

These cavities have sometimes smooth walls, when the solidification proceeds quickly, as, for example, in steel, high in carbon; sometimes streaked walls on which projecting tiny drop-like grains appear.

These blow holes are generally pear-shaped, rarely cylindrical or spherical. The first form is easily explainable. The gas separates first on the solidified crust and forces its way into the still pasty mass. This part becomes saturated more and more with gas, the pressure of which increases and the cavities will necessarily be elongated with their long axis perpendicular to the cooling surface.

The place of separation will depend upon the rapidity of the solidification, which, in turn, will depend, aside from the heat conductivity of the mould, on the temperature of the iron when poured. In "hot" poured metal, the cavities show on or near the surface. Some castings are, on account of this, unsightly and worthless unless they be worked into shape, while they may be free from cavities in the interior, and, therefore, are really of good quality.

In "cold" poured metal the cavities appear wholly in the interior. Those castings of which the interior is to be bored out, for example, gun barrels, are purposely poured relatively cold.

The internal formation of blow holes by gases may be sufficiently well detected when the upper surface does not show a

* "The Iron and Steel Magazine."

concave form, but a perceptible swelling which, with a moderate separation of gas, produces a convex surface, and with a more powerful separation of gas a scattering of the metal. In the latter case one may be certain that a slaggy casting full of holes, and even porous, has been produced. A steel refined by an addition of silicon or aluminium never shows this phenomenon. On the other hand, an over-refined steel, especially one from the converter, or one which was refined by an addition of manganese, is much inclined to this accident.

The steel-maker will easily learn to avoid these defects by correct handling of the molten metal, by slow cooling and by the proper addition of silicon or aluminium. In the molten metal one may introduce, without decreasing its toughness, from 0.1 to 0.3 per cent. of silicon; while the amount of aluminium should generally be only 0.03 to 0.05 per cent.

It is difficult to regulate properly the casting temperature, since there is a complete lack of measuring instruments for this purpose.

Shrinkage Cavities.

Very different from the gas cavities are the shrinkage cavities, that is, those cavities or "pipes" which form unavoidably in consequence of the contraction of the steel on cooling. To be sure these cavities, when they occur in the interior of the casting, are filled with gas, usually hydrogen, but if no gases were present in the steel, gasless cavities would still occur. The gas present between the crystals of the steel is drawn into these cavities, because of the rarefaction of the air which they contain.

The shrinkage cavities occur especially when the steel remains longest in a fluid condition. If, on solidification, opportunity is given the steel to contract freely, no shrinkage cavities will be found, while if this opportunity be denied, one or more cavities must necessarily occur in the interior.

For the most part such inner cavities are revealed by a depression of the upper surface where this lies nearest to the cavity. Such depressions are especially found on the uncovered surface of the sinking head where the metal was poured in. These depressions are generally considered as a good indication of a successful cast, and it is assumed, if they are deep enough, that no gas cavities are present in the interior.

In general, that steel is most liable to such cavities which contains the most occluded gases; therefore, open-hearth steel will suffer from this defect more than crucible steel, while it will be most pronounced in Bessemer steel. Very essential, however, is the correct chemical composition of the steel in respect to carbon and other elements. Of course, the shrinkage cavities are the more dangerous the richer the metal is in gas, because the expanding gases prevent the depression of the crust. Hence, it is evident that those means which check gas cavities, such as additions of silicon, aluminium, and manganese, may also be applied to decrease the size of shrinkage cavities or pipes.

Small, rather evenly distributed cavities and pores, which are found between the crystals and become visible by means of the microscope after filing and polishing, are likewise to be attributed, in most cases, to the separation of the gases, which takes place in the solidifying and pasty condition of the metal so that they cannot escape. These pores are essentially harmless. Formerly, in the manufacture of steel castings they caused troubles, but they have now been overcome. An even distribution of these little pores is obtained by an even and strong pressure before and during solidifying.

In order to lessen or avoid shrinkage cavities in steel, the most certain means is the application of properly-shaped sinking heads at those places where the shrinkage cavities would appear, that is, where the metal remains longest fluid; as from these the still molten metal flows into the weaker parts where it solidifies quickly. As soon as this flow ceases, cavities must naturally be formed. Each part of a casting is to be considered as a sinking head for the part lying below it, and from this may be inferred the best way in which castings should be moulded; that is, in such a fashion that the smaller cross sections are placed below and the larger ones above and the latter provided with effective sinking heads.

Concerning the proper moulding of such pieces, Paul Friem, of Neuberg, recently read a paper which appeared in the January, 1905, number of "Stahl und Eisen." He says correctly: "The standpoint of most complete filling of the mould must determine that arrangement as the most favourable which permits the application of risers to all places where they are necessary. Whether the inclined or horizontal moulds fulfil this purpose best will depend on the shape of the casting and the demands made upon it when in use."

The shrinkage cavities depend, however, not only on the form of the moulds, but also on the casting temperature of

the metal. The cavities, when they occur, are larger the hotter the metal is when poured. But even a relatively cold metal will give rise, especially in thin-walled castings, to the formation of cavities in the interior, because, by the quick solidification of the crust, the pressure of the fluid metal is prevented. Both reasons often work together. The thinner the walls of the casting, the higher the temperature must be, and the more must sudden alterations of the cross section be avoided, and conversely the choice of casting temperature must be determined by the proportions of the cross sections.

With the casting temperature is immediately connected the speed of pouring. The formation of cavities is less if the mould is filled slowly, because some pressure occurs even during the pouring. However, the danger arises with thin castings that the mould may not be filled completely, while with heavy pieces under too long an influence of severe heat the walls of the mould may suffer greatly. In general, one will prefer the formation of large cavities from quick pouring and try to make them harmless. Most harmless are those which occur in the middle of large pieces where they can be filled by pressure. If, at the same time, on the surface of the cast or on the riser a solid layer forms this must be broken in order to afford entrance to the metal poured in afterwards.

Gas cavities can also arise from other sources, and one must distinguish between those which are due to the operation of pouring (air bubbles) and those due to the substance of the mould (steam cavities).

Air Bubbles.

If the metal be poured in a high stream, it carries air with it just as when water is poured with a high stream into a vessel. The air seeks to come to the surface and escape. If it is prevented, for example, by a small departure of the flowing metal from a perpendicular line into a horizontal one, or by spaces in the mould, the air gathers and either hinders the filling of the mould, or remains enclosed in the metal. Such cavities may be avoided by two means: (1) by pouring with a low stream, (2) by a correct arrangement of the mould, in respect to the connection of all the higher parts with the outer wall by perpendicular risers.

Steam Cavities.

By steam cavities are meant all cavities produced by the development of steam or gases from the substance of the mould, hence not only by steam, but by carburetted hydrogen which develops from the carbon mixed with the substance of the mould, by carbonic oxide, etc. The cause of this development is the dampness of the mould. Cavities of that sort are avoided by the careful drying of the mould and the application of correctly placed channels wherever steam can develop, both on the outer mould and on the cores. To be sure the surest preventive against influences of that kind is a well-dried or baked mould, heated at least above 100 degrees C., but success in producing good work may be obtained also in undried or unbaked moulds, even in green sand; only one must always take care to provide for the escape of air and steam.

On the other hand, from excessive development of steam, damage to the mould and even explosions may occur, and, therefore, undried moulds can be used only for the manufacture of small and thin castings. The most favourable case is that in which the moulds have such a temperature that the taking up of hydroscopic water is prevented. The rule is to make the moulds of a mixture of unbaked and baked clay to which has been added graphite, coke, or powdered wood charcoal.

Surface Cracks.

are a very interesting, but a very differently explained, phenomenon. When one has prepared a mould in the best possible manner, taken into consideration all the relations of shrinkage, and is certain of pouring without internal cavities, if, upon stripping, pieces of the mould are found sticking to the casting, one can be certain that under these pieces, when they are scraped off, will be found worm-like impressions in which the substances of the mould were imbedded, while otherwise a smooth surface appears. Generally these impressions are not deep, so that the usefulness of the casting is not thereby impaired, but they make unsightly work. To be sure, these surface cracks are often found in the same casting in which shrinkage cavities, not gas cavities, are present.

Their origin is ascribed to a gas pressure which arises from steam developed in the substance of the mould, since such markings never appear in castings poured into iron forms. They are said to occur most frequently when the substance of the mould is prepared from clay, baked clay, and graphite, less often in those consisting mainly of quartz.

Since the shrinkage cavities are not produced by the separation of gases, and hence have in the interior no great

counter pressure, a small pressure on the exterior can make impressions similar to these markings. The author is also of the opinion that this phenomenon is to be ascribed to the gases of the substance of the mould. Others explain them as due to the different solidification of the constituents of the steel, and, in fact, microscopic examination shows that on their edges the steel contains much pearlite and less ferrite, at least more pearlite than at a slight distance away. Hence, one would explain these markings as a phenomenon of segregation; the elements remaining last fluid sinking deepest. In fact, in the solidification of alloys, for example, tin and lead, one can at will produce similar phenomena.

Cracks.

Steel castings often show, after cooling, more or less fine cracks, which arise either in the mould or after stripping. In technical language the former are called "hot cracks," the latter "cold cracks," but both kinds run into each other. The cracks in the mould, hot cracks, are produced by the resistance of the mould to the contraction occurring during cooling; and their production is favoured by great inequalities in the cross sections of a casting and by sharp corners.

Moreover, a metal which possesses great tenacity in a hot condition is less exposed to this evil than a red-short metal; for example, an iron with a high percentage of sulphur or of sulphur and copper. Although one attributes to phosphorus only influence on cold cracks, yet this element also gives rise to hot cracks, because it lessens the tenacity in a hot condition though in a less degree than sulphur.

According to the experiments of Friem, a steel with 0.05 per cent. of phosphorus is susceptible to hot cracks. In this respect one has taken into consideration the known properties of foreign elements on carbonised iron at different temperatures.

Hot cracks, which, as said above, occur especially at projecting corners, are most surely avoided by the removal of all hindrances to contraction. For this purpose, after the pouring the resistance to the contraction must be lessened or removed by loosening the opposing parts of the mould.

Three methods may be pursued here: either the walls of the mould are made so weak at those places that they are broken by the contraction of steel; or, immediately after the solidification of the iron the opposing parts of the mould are knocked away; or the casting is chilled at these points by the application of water, of a piece of ice, or of cold iron, etc. Therefore, the accessibility of such points must be considered in the formation of the mould and the mould-boxes must be correspondingly constructed.

The method of allowing the opposing parts of the mould to be broken by the steel is achieved by applying a soft material at those parts, for example, no burnt material, but a moulding sand merely well dried or thin plates of clay. Thus one may insert thin plates of clay between the spokes and the rim of toothed wheels, and leave free the intervening space though filled with loose material, in order that they may not be displaced, such as bits of stone, wood, charcoal, or brick. One may also make the moulds, especially the cores, of material which is united by substances easily burned out by the heat. For example, the moulding substance may be mixed with molasses, syrup, and rye meal.

In the application of the second method, *i.e.*, uncovering the danger points so that they may cool more quickly, one must proceed just as carefully. The correct execution depends almost entirely on the skill of the moulder.

Cracks always arise at such places which remain longer fluid than their surrounding. A quick cooling may be obtained by the third method; for example, by means of water. This is the method most easily employed, as shown by sufficient experience of the founder. At the proper points, channels are dug in the superfluous substance of the mould and water is poured in so that the iron will be quickly brought into the solid state. Besides, in the moulds themselves, pieces of iron may be used, which being good conductors of heat, bring about a more speedy solidification. To be sure these inserted pieces of metal may cause damage. In car wheels which are cast in iron moulds in order to make the rim hard are often found, in consequence of the quick cooling, cracks at the axle. Hence, one must see to it that a good quantity of liquid material is provided here in order to follow up the contraction. In general the rule holds, that wherever the formation of cavities may occur, the danger of cracking is greatest. A last method, little used, is the use of clamps, which hold the parts together. In this case, however, hot cracks may, nevertheless, occur without being visible to the eye.

After cooling, the castings often warp, due to unequal contraction. This can only be avoided by an even cooling and the corresponding contraction of the form.

For the same reason, so-called cold cracks occur after solidification, which are likewise consequences of tensions which arise through unequal cooling of the casting. They differ from hot cracks generally by being thinner and having rough edges, while the hot cracks run in straight lines with smooth edges. They are also often hardly noticeable to the naked eye, and appear generally only upon working the casting, but they frequently run clear through the cross section. Ingot iron rich in carbon is, in this respect, more susceptible than ingot iron poor in carbon. That is the reason why one obtains crackless castings more easily from the basic than from the acid furnace.

OBITUARY.

MR. JAMES MANSERGH, Past-President of the Institution of Civil Engineers.

MR. W. GILLIATT, several years connected with Yorkshire steel works, at an advanced age.

MR. G. P. TORRENS, a director of the Shelton Iron and Steel Company, Limited, of Stoke-on-Trent.

MR. THOMAS LISTER, until a few years ago, architect and surveyor to Messrs. Marshall & Company, of Gainsborough.

MR. J. P. GREENALL, the representative for the last twenty years of R. Russell & Sons, Limited, Peel Foundry, Derby.

MR. T. K. HILL, of the firm of Thos. Hill & Sons, engineers and boiler makers, of Heywood, near Manchester, in his 49th year.

MR. E. M. MITTON, who for many years carried on business as an engineer at the Crescent Foundry, Birmingham, at the age of 82.

MR. P. F. IBBOTSON, principal of the old-established firm of Thomas Ibbotson & Company, edge tool manufacturers, Sheffield. He was 71 years of age.

MR. ENOCH BALDWIN, who, until a few years ago, was engaged in business in connection with the firm of Baldwin, Son, & Company, ironfounders, Stourport, which was established by his grandfather, and of which he subsequently became the principal partner. The deceased was 81 years of age.

A FIRE occurred during the month at the factory in Birmingham, of Messrs. Jones & Foster, brassfounders, but only slight damage was done.

TRADE TALK.

FERRANTI, LIMITED, have discontinued the manufacture of engines.

MR. G. PAUL has just established the Duncannon Foundry, Denny, Stirlingshire.

THE CRANE FOUNDRY COMPANY, LIMITED, has been registered with a capital of £20,000 in £10 shares.

THE RICHARDSON & PRICE ENGINEERING COMPANY, LIMITED, has been formed with a capital of £100 in £1 shares.

THE ORMOND STREET ENGINEERING WORKS, Bury, will be offered for sale by public auction on July 5.

MR. H. ALLEN, metallurgical chemist, etc., has removed to 19, Old Queen Street, Westminster, S.W.

THE average net selling price of Scottish manufactured iron during March and April was £5 15s. 11.32d. per ton.

THE SIMPLIFIED UNDERGROUND CONDUCTOR COMPANY, LIMITED, have temporarily closed their London offices.

CAMMELL, LAIRD & COMPANY, contemplate constructing a gun testing range near North Plain, Bowness-on-Solway.

MR. PERCY LONGMUIR has commenced practice as a metallurgist and metallographist at 30, Coleshill Road, Teddington, S.W.

A RECEIVING order has been made in connection with the affairs of Mr. B. Elton, ironfounder, Edgbaston and Tipton.

THE SWAN AND SMALL HEATH FOUNDRIES, West Bromwich, belonging to J. & S. Roberts, Limited, will be offered for sale by public auction on June 20.

THE STORA KOPPARBERGS BERGSLAGS AKTIEBOLAG AGENCY, LIMITED, have removed to 6, Laurence Pountney Hill, Cannon Street, E.C.

WALTER SOMERS & COMPANY, LIMITED, have put down a new press at their Haywood Forge, Halesowen, to work ingots up to 80 tons weight.

THE CROSS FOUNDRY AND ENGINEERING COMPANY, LIMITED (capital £3,500 in £10 shares) has been formed, with registered offices at Gorseinon, Glam.

A DISSOLUTION of partnership is notified in connection with the affairs of Messrs. R. J. Lines, W. H. Tangye, and T. Carroll, engineers, Northampton.

A NEW concern, styled the Glyco Metal Company, Limited, has been formed, with a capital of £16,000 in £1 shares, to carry on the business of metallurgists, etc.

At Dudley County Court, recently, a petition in bankruptcy was filed on behalf of J. Godfrey, iron works manager, of Compton Road, Park Lane, Tipton.

The Holm Foundry Company, Limited, has been registered with a capital of £3,000 in £1 shares, with a registered office at Glencairn Street, Kilmarnock.

Messrs. P. J. Purdy and H. Wilson, engineers, etc., Manchester, trading under the style of Purdy Patents Company, have dissolved partnership.

A receiving order has been made in connection with the affairs of Mr. B. Elton, ironfounder, late of Edgbaston, Warwickshire, and Tipton, Staffordshire.

The Simplex Steel Conduit Company, Limited, have found it necessary to build entirely new manufactories at Garrison Lane and Maxstoke Street, Birmingham.

Redpath, Brown & Company, Limited, have recently opened, at Trafford Park, Manchester, large works for the manufacture of constructional steel work in all branches.

C. Madan & Company, Limited, engineers, of Salford, Manchester, have removed to Broadheath, where they have erected works for the production of their specialities.

Hudswell, Clarke & Company, Limited, of the Railway Foundry, Leeds, are supplying four locomotives—fitted with bogies and tenders—for a Central American railway.

Albert Jordan & Company, Limited, have purchased the business of a general, mechanical, and constructional engineer, etc., carried on by A. Jordan, at 121, St. John's Street Road, E.C.

Kosmoid, Limited, anticipate opening their new works at Dumbarton in about three months' time, when they will commence the manufacture of tubes and locks by the Dr. Shield's process.

The total liabilities in connection with the affairs of the Darlington Wagon and Engineering Company, Limited, have been returned at £87,846, and the assets at £72,472.

The balance-sheet of the Nova Scotia Steel and Coal Company for 1904 shows assets totalling $12,406,050, as against $10,879,149 in 1903, and $9,675,101 in 1902.

The Weston Electrical Instrument Company, of Newark, N.J., U.S.A., have established a branch office and laboratory at Audrey House, Ely Place, Holborn, E.C.

A fire broke out recently in the general store at the works of the Clydebridge Steel Company, Limited, Cambuslang, doing damage to the extent of about £700.

The Cargo Fleet Iron Company, Limited, of Middlesbrough, have recently made an issue of 3,700 4½ per cent. first mortgage debentures of £100 each at 92 per cent.

"Electrical and Thermal Conditions in Alloys" was the subject of an interesting lecture given recently by Mr. A. Adams before the Birmingham Metallurgical Society.

The Holwell Iron Company, Limited, of Asfordby, near Melton Mowbray, are supplying pipes and castings to the Metropolitan Water Board during the current year.

Orders have been issued at the North-Eastern Railway Company's works at Gateshead for the construction of 20 new class locomotives of average weight and haulage capacity.

Messrs. E. C. Catling and A. M. Catling, junior, engineers, Radnor Street, City Road, E.C., trading under the style of E. & M. Catling, have dissolved partnership.

Grant, Ritchie & Company, Limited, have acquired the business of Grant, Ritchie & Company, Townholm Engineering Works, Kilmarnock. The capital is £25,000 in £5 shares.

Benton, Keighley & Reynolds, Limited, have been registered with a capital of £2,500 in £1 shares, to acquire the engineering business of Lennox, Benton & Reynolds, Limited.

Considerable progress is being made with the steel rail mill of the Dominion Iron and Steel Company, at Sydney, N.S. The full capacity of this mill will be 500 tons per shift or 1,000 tons per day.

The newly-formed Association of Welsh Steel-bar Makers has been dissolved, members preferring to act independently. The last prices fixed were—for Siemens' £4 7s. 6d. and Bessemer £4 6s.

Applications have been invited for shares and debentures in Johnson & Phillips, Limited, to the extent of £116,667 debenture stock and 116,667 ordinary shares of £1 each, at par.

Johnson & Phillips, Victoria Works, Old Charlton, have appointed Mr. D. Wells, of Rue de la Pepiniere, 10,

Brussels, their agent-general for Belgium, Holland, and the North of France.

THE average selling price of manufactured iron in the North of England for the two months ended April 30 was £5 17s. 8.44d. per ton, as against £5 17s. 6.76d. per ton during the previous two months.

THE formal opening of new constructional engineering works near Bolton of Messrs. John Booth & Sons has been performed during the month. The firm have designed and built the new structure themselves.

MESSRS. T. ALDERSON and S. ASHWORTH, of Dewsbury, have dissolved partnership. The business will be carried on by Mr. Ashworth, under the style of Ashworth, Son & Company, Midland Iron Works, Watergate, Dewsbury.

S. A. DANIEL, LIMITED, Lion Works, Birmingham, have purchased from Messrs. J. C. Dalman & Sons, the stock, patterns, and goodwill of their business in copying presses, etc., carried on at the Chunk Foundry, Birmingham.

MESSRS. P. S. COULDREY, A. HILL, and C. H. STEWART, consulting engineers, Old Broad Street, E.C., trading under the style of Alexander Hill & Stewart, have dissolved partnership, so far as regards Mr. P. S. Couldrey.

ANDREW BARCLAY, SONS & COMPANY, LIMITED, of the Caledonia Works, Kilmarnock, are extending their machine shop. Redpath, Brown & Company, Limited, of Edinburgh, are supplying the necessary columns.

THE business of malleable ironfounders carried on by John Maddock & Company, at Oakengates, Salop, has been acquired by John Maddock & Company, Limited, which has been formed with a capital of £40,000 in £1 shares.

THE LONDON AND NORTH-WESTERN RAILWAY COMPANY are now working a class of engine—8-coupled goods—which, as originally built, was three-cylinder compound, but is now being converted into two-cylinder simple.

AT the Darlington Forge Works, recently, the stern frame of one of the new Cunard vessels has been successfully cast. The casting, which is of steel, is the largest of its kind which has been made, the molten metal used weighing 70 tons.

THE business of Alexander Liggat & Company, engineers and brassfounders, Caledonian Brass Works, Barrhead, has been turned into a limited liability concern, with a capital of £8,000 is £1 shares.

THE EAST COAST BOILER WORKS COMPANY, LIMITED, is the style of a company formed to acquire the business carried on in Southdown Road, Great Yarmouth, as the East Coast Boiler Works Company. The capital of the concern is £2,000 in £1 shares.

THE Babcock boiler appears to be appreciated in Australia, over 50 mines being equipped with these boilers. At Broken Hill there are also 30 distributed amongst the mines, water works, and electric supply, while in Western Australia there are now 68 in use.

EVERETT, EDGCUMBE & COMPANY, LIMITED, is the style of a concern registered with a capital of £20,000 in £1 shares, to acquire the business of mechanical engineers carried on at Hendon and at 87, Victoria Street, Westminster, as Everett, Edgcumbe & Company.

WILLIAM EDWARDS & SON, LIMITED (capital, £50,000 in £10 shares) has been registered to acquire the business carried on at the Griffin Works, Horseley Road, the New Griffin Works, Colliery Road, and the Eagle Edge Tool Works, Bilston Road, Wolverhampton, by William Edwards & Son.

THE hearing of a claim by Messrs. Pease & Company, of Darlington, against Messrs. Pearse & Company, for £1,500 in respect of engineering work executed at the Worcester branch of the company's works, was recently concluded at Leeds. In respect of damages for alleged breach of contract, there was a counter-claim of £4,500. Judgment was given for plaintiffs for £1,390, with costs, and also judgment on the counter-claim, with costs.

IN a report on the Dudley chain and nail industry, a lady inspector of factories says that chain and nail-making may be classed as a home industry, the shops being in the rear of the cottages. In each workshop there are several benches or "stalls," on which the metal is shaped, and in the centre a large furnace with bellows, or in the chain workshops a small furnace to each stall. Whole families are found employed in one workshop.

A LITTLE over two years ago the Council of the Society of Arts announced that they were prepared to award, under the terms of the Benjamin Shaw Trust, a gold medal, or £20, for the best dust-arresting respirator for use in dusty processes and in dangerous trades. The matter was referred to a committee, who have come to the conclusion that in none of the apparatus sent in was there sufficient originality to justify the award of a prize.

Established 1863.

Jas. Durrans & Sons,

PHŒNIX WORKS, PENISTONE,

Nr. Sheffield.

Manufacturers of all

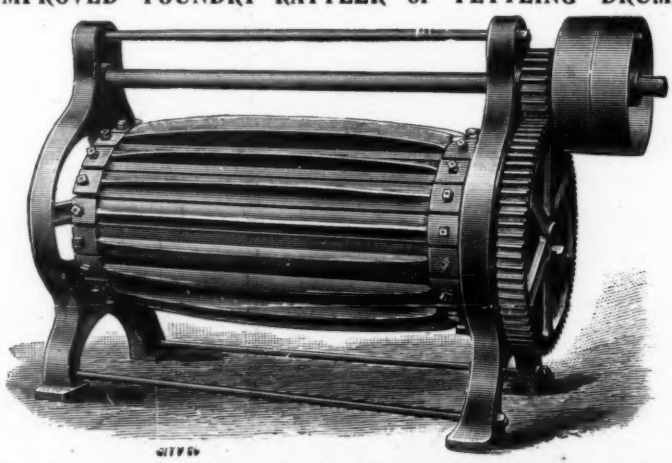
FOUNDRY EQUIPMENTS

Composition Black Lead,

Plumbago, Core Gum, White Dust, and Coal Dust.

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, &c.

IMPROVED FOUNDRY RATTLER or FETTLING DRUM.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

COMPANY NEWS.

Cargo Fleet Iron Company, Limited.—Interim dividend of 1s. per share (5 per cent.).

S. P. Austin & Son, Limited.—Net annual profit, £13,533; dividend, 5 per cent. on the ordinary shares; carry forward, £17,790.

J. G. White & Company, Limited.—Annual profit, £15,023; ordinary dividend, 6 per cent.; reserve fund, £5,000; carry forward, £12,679.

W. Summerscales & Sons, Limited.—Net profit for year, including balance brought forward, £5,378; dividend, 5 per cent. on the ordinary shares; carried forward, £170.

Pather Iron and Steel Company, Limited.—Net profit, £4,966 1s. 2d.; ordinary dividend, 10 per cent. per annum; reserve fund, £1,000; carry forward, £1,783 15s. 11d.

Midland Coal, Coke, and Iron Company, Limited.—Annual profit, £3,052; after deducting usual sums there remains £656, which has been transferred to the "A" debenture interest account.

Metropolitan Amalgamated Wagon Company, Limited.—Net annual profit. £200,710; reserve fund, £50,000; ordinary half-yearly dividend, 12½ per cent. per annum; carrying forward, £51,032.

William Cooke & Company, Limited.—Net profit for year, £9.433; brought forward, £2,011; final ordinary dividend, 5 per cent. (making 7½ per cent. for the year); reserve fund, £1,000; carry forward, £2,219.

Hallamshire Steel and File Company, Limited. — Including £1,697 4s. 8d. brought forward, there is a net profit of £4,290 16s.; dividend, 15s. per share, absorbing £2,250, leaving £2,040 16s. to be carried forward.

Ebbw Vale Steel, Iron and Coal Limited.—Outlay on new plant, £27,312, charged to the revenue of the year; brought forward, £19,224; gross annual profits, £87,283; ordinary dividend, 5 per cent. per annum; carried forward, £10,468.

—o—

PERSONAL.

The late Mr. T. Brogden, of Appleby & Brogden, ironfounders, Scarborough, left estate valued at £2,154 gross.

Sir John Wolfe Barry succeeds the late Mr. James Mansergh as chairman of the Engineering Standards Committee.

Sir William Mather, the well-known engineer and ironmaster, has had the degree of Doctor of Laws conferred on him by the Princeton University.

Mr. W. O. Dayson, late chief engineer under the Blaenavon Iron and Steel Company, Limited, has been the recipient of a presentation on resigning his appointment.

The late Mr. E. W. West, of Henry Wilson & Company, Limited, engineers, and iron and brass founders, Cornhill. Liverpool, left estate of the gross value of £10,897.

Mr. T. P. Barker, general manager of Thomas Piggott & Company, Limited, has been appointed general manager of Ashmore, Benson, Pease & Company, Limited, Stockton-on-Tees.

Mr. J. Gavey, engineer-in-chief to the Post Office, has been elected President of the Institution of Electrical Engineers. Dr. R. T. Glazebrook, director of the National Physical Laboratory; Mr. J. E. Kingsbury, of the Western Electric Company; Mr. W. M. Mordey, and Mr. W. H. Patchell have been elected Vice-Presidents of the Institution.

Ganister, Cupola Blocks, Fire Bricks,
Fire Clay.
Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.
Steel Moulders' Composition, Silica Cement.

J. GRAYSON LOWOOD & Co., Ltd.,
DEEPCAR, nr. SHEFFIELD.
Telegrams: "LOWOOD, DEEPCAR."

ELDERS FOUNDRY COKE

As supplied to the British . . Admiralty Dockyards.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time.

We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blow-holes and other defects, than we formerly did.

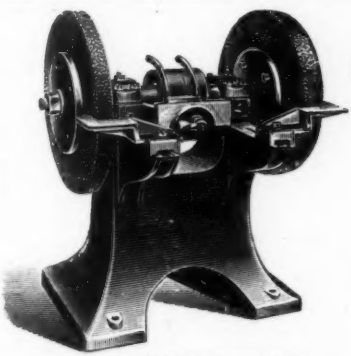
From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

In reference to the Foundry Coke you have been supplying us with for the last six months, we have very great pleasure in letting you know that it has given every satisfaction, and that our Works Manager and Workmen give it the highest praise.

Elders Navigation Collieries, LTD. Cardiff.

Nearly Fifty Years' EXPERIENCE in the Manufacture of Grinding Machines.



Machines complete with EMERY or CORUNDUM WHEELS, from £2 to £60.

"CD" TYPE, MEDIUM GRINDER.

Mitchell's Emery Wheel Co.

MILL STREET, BRADFORD, MANCHESTER.

Also at LONDON, GLASGOW, and BELFAST.

PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1904-5.	1903-4.
Iron—Scotch pig warrant ... ton	51/5	51/6
—Middlesbro' warrants ... ... ton	45/6½	42/5
—W.C. M/nos Bessemer ... ... ton	57/6	55/0
—Stock, Scotch, May 27 ...tons	17 750	9,560
Copper—Chili bars, GMB ... ... ton	£65 15/0	£56 15/0
—Stock, Europe & afloat... ... tons	18,035	11,137
Tin—English ingots ton	£140	£124
—Straits ... ton	£139 5/0	£118
—Stock, Ldn. Hlnd and afit ... tons	12,824	14,789
Lead—English pig ton	£13 12/6	£11 12/6
Spelter—Ord. Silesian ... ... ton	£23 17/6	£21 5/0
Quicksilver-(75lb.) bottle	£7 7/6	£8
Antimony—Regulus ... ... ton	£38 10/0	£29

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 10 0	to	7 0 0
Pipes, 1¼ to 2½ in.	5 0 0	to	5 5 0
,, 3 to 4 in....	4 12 6	to	4 17 6
,, 5 to 8 in.	4 10 0	to	4 12 6
,, 10 to 16 in....	4 10 0	to	4 12 6
,, 18 to 24 in....	4 10 0	to	4 12 6
Chairs	3 10 0	to	3 12 6
Floor plates (open sand)	2 15 0	to	2 17 6

SCRAP.

The quotation for scrap subject to market fluctuations is as follows: —Engineers' heavy scrap, 50s. to 52s. 6d.; ditto light scrap, 20s. to 22s. 6d.; clean scrap brass, 39s. 6d.; clean scrap copper, 60s.; lead (usual draft), 11s. 9d.; tea lead, 10s. 9d.; zinc, 17s. 3d.; hollow pewter, 100s.; black pewter, 65s. per cwt.

GRAHAM, MORTON & COMPANY, LIMITED, have secured a contract from the Tottenham and Edmonton Gas, Light and Coke Company for the supply and erection of a new retort house and the necessary coal and coke handling plants.

SILICA FIRE BRICK Co.,

OUGHTIBRIDGE.

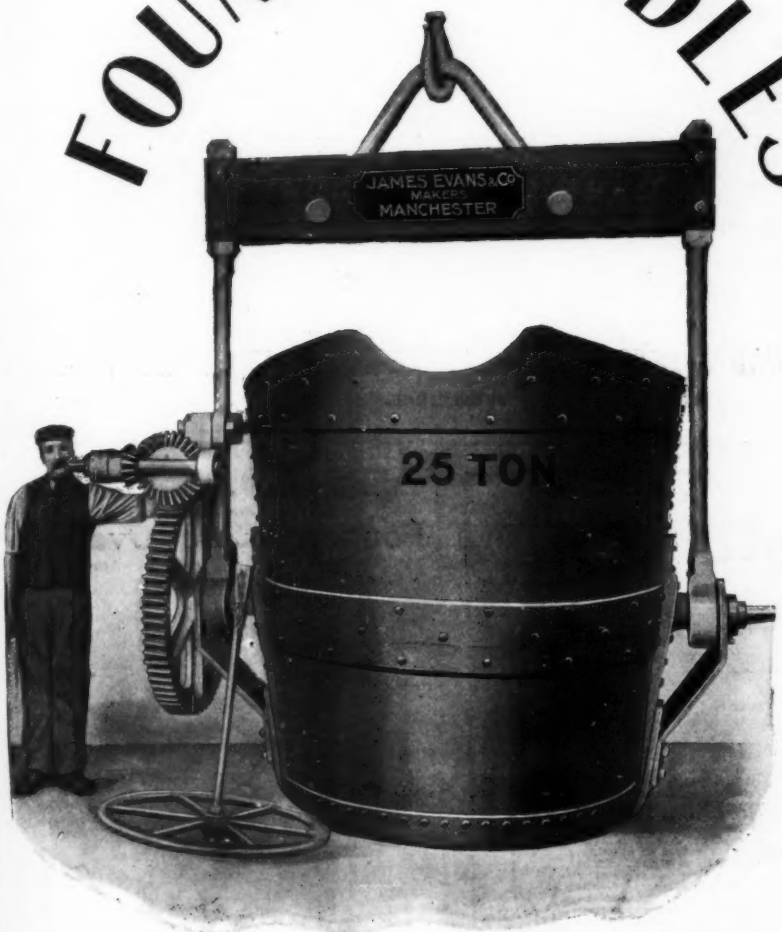
GROUND GANISTER,

Wet or Dry.

Silco Cupola Bricks, 90 % Silica.

Contractors to H.M. Government.

FOUNDRY LADLES

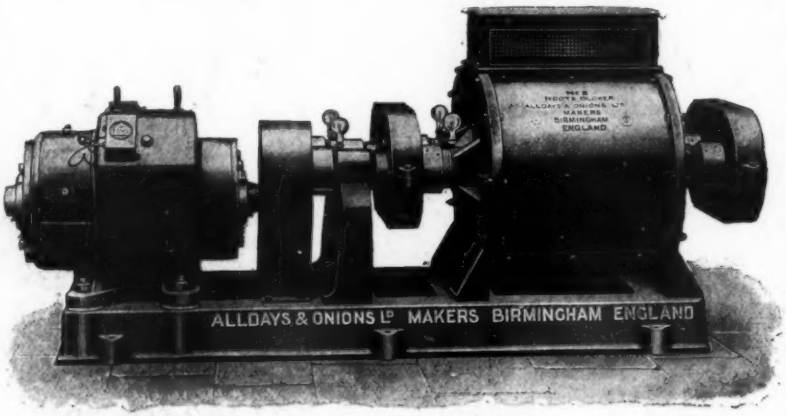


JAMES EVANS & Co., FOUNDRY ENGINEERS,

Telegrams:
"LADLES, MANCHESTER."

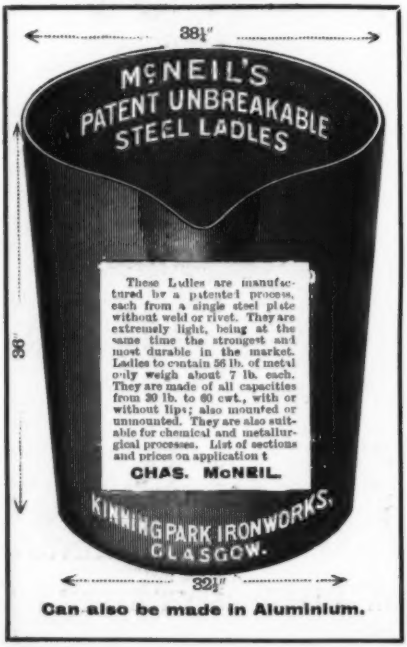
BRITANNIA WORKS, MANCHESTER.

ROOTS BLOWERS.



ALLDAYS & ONIONS PNEUMATIC ENGINEERING CO., LTD., BIRMINGHAM.

AND AT 20 BUCKLERSBURY, LONDON, E.C. Telegrams: "ALLDAYS, BIRMINGHAM."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PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application t
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36"
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Can also be made in Aluminium.

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Registered and Improved

Foundry Core Oven,

Indispensable in any Foundry using small Cores.

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OVEN BUILT IN WALL

4 Shelves, each 10 inches deep. Sizes: Front width, 3 ft. 6 in.; height, 4 ft. 8 in. Inside, width, 3 ft.; depth, 2 ft. 7 in.; height, 4 ft. 3 in.

Price, £12 10 0

CHARLES D. PHILLIPS,

Emlyn Iron Works. NEWPORT (Mon.).

HUB IS NOT THROWN AWAY

when our

ECONOMY BRUSH

is worn out, because you can place fresh layers of Steel Wire on it yourself.

Used on Emery Grinders, they are found invaluable for

CLEANING CASTINGS.

Many other uses are always being found for them.

THE SPECIAL WIRE DOES NOT LAY DOWN OR BREAK OFF.

SIZES, 15 INCHES DIAMETER DOWN TO 8 INCHES.

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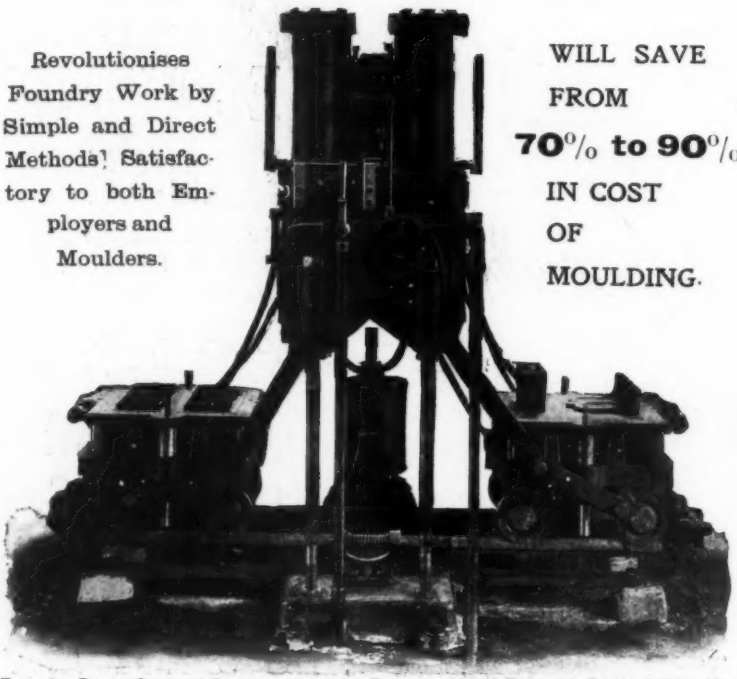
SAND MOULDING MACHINE

Revolutionises Foundry Work by Simple and Direct Methods. Satisfactory to both Employers and Moulders.

WILL SAVE FROM **70%** to **90%** IN COST OF MOULDING.



Type A.—Power Operated Carriage run under Rammer, Mould Rammed, Carriage Returned and Box Lifted, all Automatically. Arranged for one or two men to work continuously.

NO OTHER SAND MOULDING MACHINE HAS THE SPEED, SIMPLICITY AND STRENGTH OF THIS.

TURNS OUT BETTER MOULDS AND CASTINGS THAN BY HAND.

THE SAFETY TREAD SYNDICATE,

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Telephone, 5646 Bank. Telegraph, "Unslipping," London.

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FOREMAN MOULDER seeks engagement; 38; thoroughly practical and experienced in the production of all kinds of general light castings; up to date in foundry practice, cupolas, and iron mixing, handling men; good references.—Address Box 181, Offices of the FOUNDRY TRADE JOURNAL, 165, Strand, W.C.

GENTLEMAN, with long experience of engineering trade in Leeds, is open to act for good class firms desiring Representation in Leeds and district. Advertiser is well known in the trade.—Address D., 77, ROBINSON'S Advertising Office, Leeds.

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WANTED, January No. of "Foundry Trade Journal."—Address offers to Box 190, FOUNDRY TRADE JOURNAL, 165, Strand, W.C.

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No. 2A size by "Daglish," Glasgow, 4½ in. outlet
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"Lloyd's" Patent Fan as new, 8 in. "
—For full details address J. LIGHT, Wolverhampton.

CASTINGS.—For Good, Sound Machinery Castings, in Green or Dry Sand or Loam, up to 15 tons in weight, and Machined if required, apply to ROSE, DOWNS, AND THOMPSON, LTD., Old Foundry, Hull. Special Quotations for Quantities.

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THE well-known FINE RED MOULDING SAND, for Iron, Brass, Aluminium, &c.—Apply MANSFIELD SAND CO., LTD, Mansfield, Notts.

CRUCIBLE STEEL CASTINGS for Collieries, Works, and Engineers, from customers' patterns; machined if desired.—P. T. WOODRUFF AND CO., Machen, Newport, Mon.

FIVE LATHES, length of beds 6 ft. to 27 ft.; Two Drilling Machines, One Planing Machine, One Shaping Machine, One Screwing Machine; Low Prices.—ATLANTIC WORKS COMPANY, Newport.

MISCELLANEOUS.

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MACHINERY OF ALL KINDS.
It will save you Time and Money.
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THE FOUNDRY TRADES
Will be interested to know that
JOHN MOODY, SON, & CO.,
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ELECTRIC, HIGH & LOW PRESSURE HYDRAULIC, and POWER DRIVEN CUPOLA HOISTS & FOUNDRY CRANES.
WRITE FOR QUOTATIONS.

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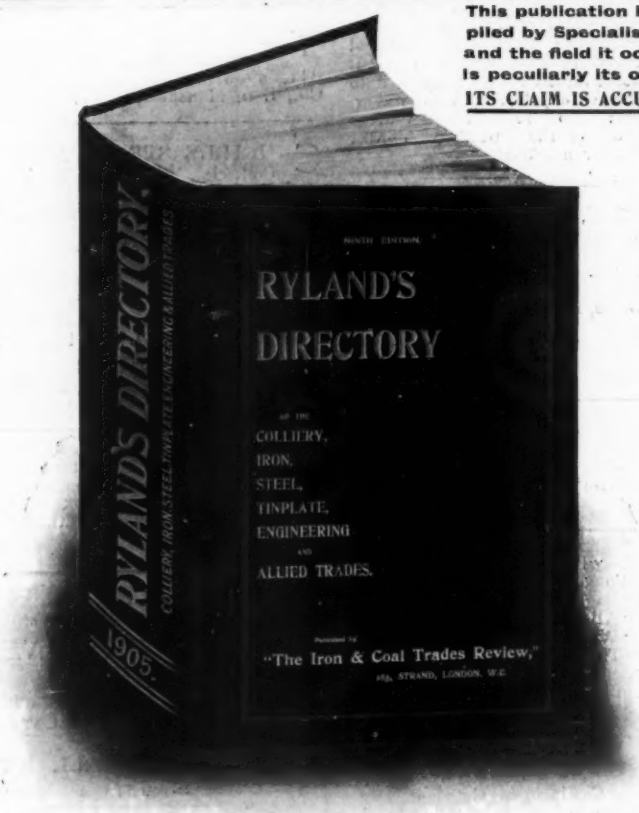

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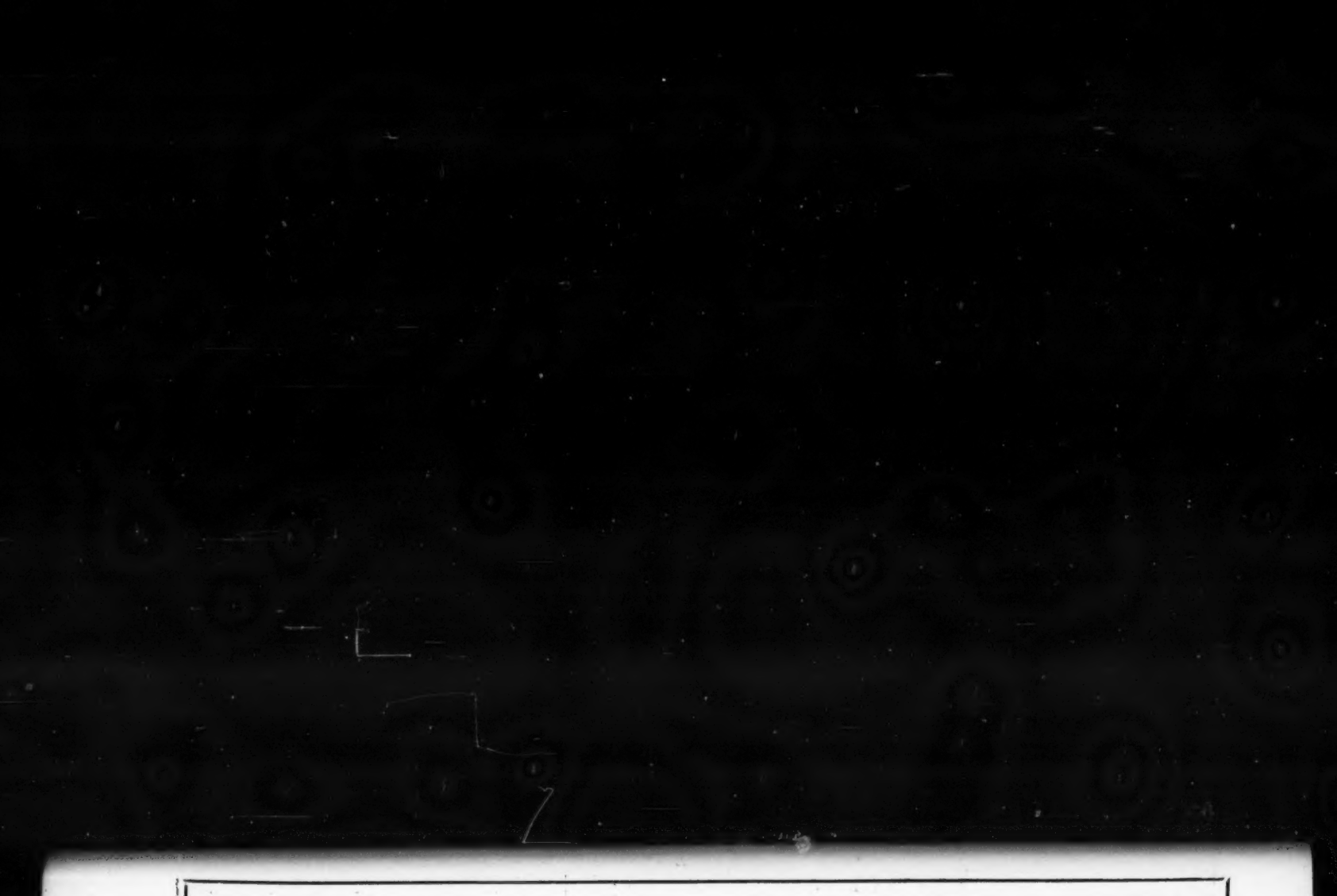
Publishing Offices: "The Iron & Coal Trades Review," 165, Strand, LONDON, W.C.